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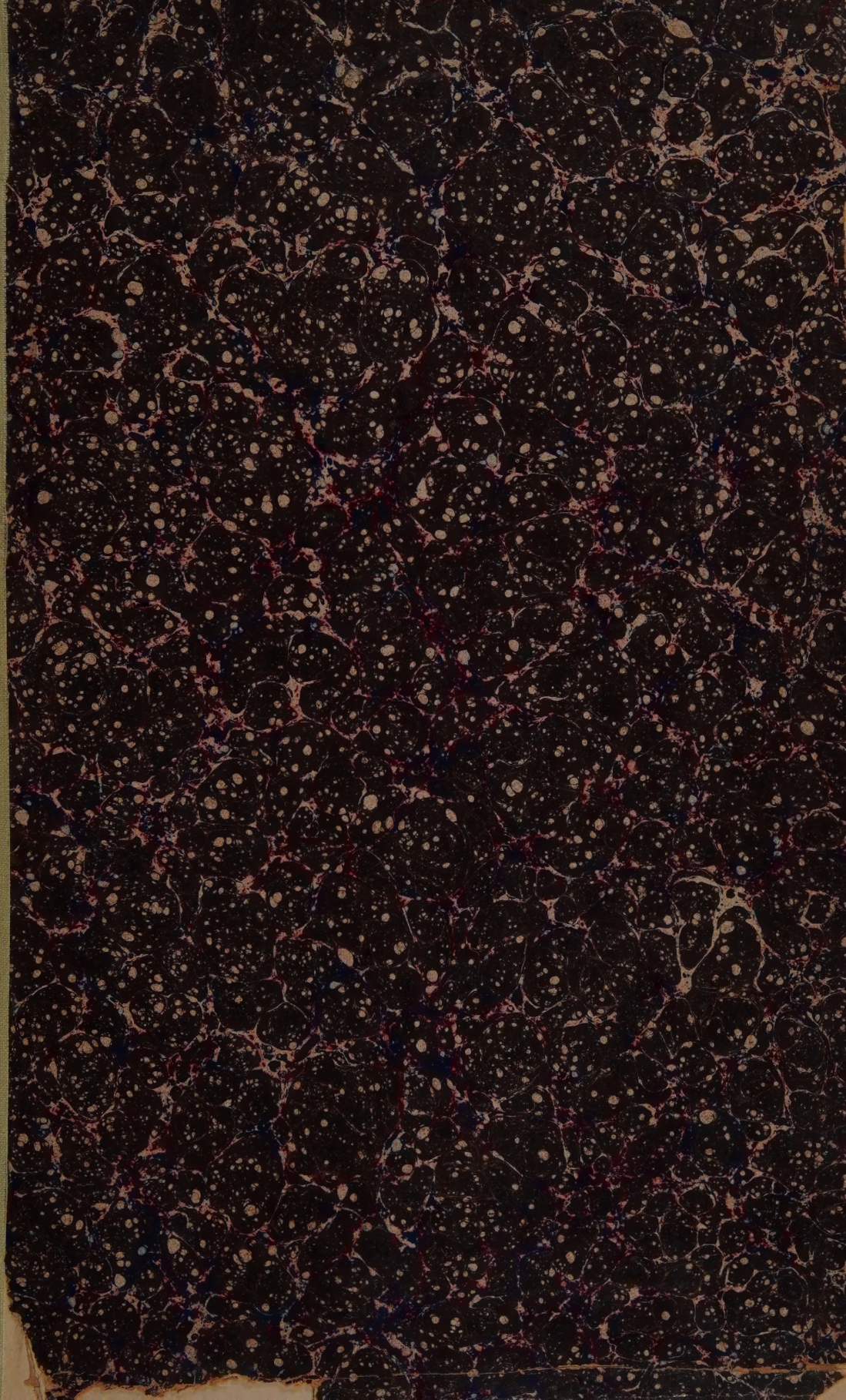
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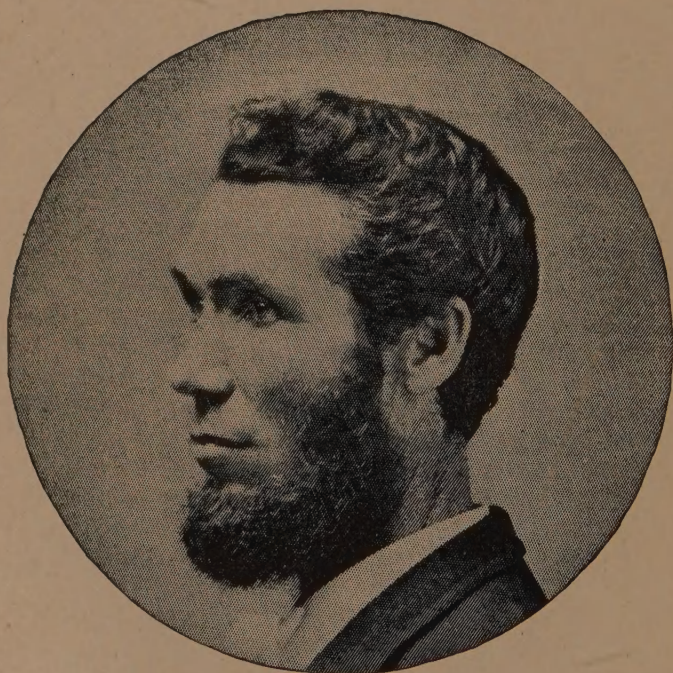
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CREATOR AND COSMOS.

BY
ROBERT SHAW, M. A.

AUTHOR OF
"COSMOTHEOLOGIES AND INDICATIONS OF JUDGMENT," WHICH INCLUDES PRINCIPALLY THE "ORIGIN OF THE MOSAIC DISPENSATION;" AN "INQUIRY INTO THE ORIGIN OF CHRISTIANITY;" "PROPHECIES OF REVELATION AND DANIEL, DEVELOPED IN THE HISTORY OF CHRISTENDOM;" AND THE "HEBREW AND PHOENICIAN COSMOGONIES;" OF "THE CHALDÆAN AND HEBREW AND CHINESE AND HINDOO ORIGINES;" OF THE "ORIGIN OF THE ANCIENT CIVILIZATION OF THE NILE'S VALLEY;" OF A "CRITICAL REVIEW OF THE HISTORY OF THE SCOTS OR GAELS," WITH A DISQUISITION UPON THE SCYTHIC RACES;" OF A "CRITICAL REVIEW OF THE HISTORY OF ANCIENT EGYPT," DURING THE THIRTY DYNASTIES OF MANETHO, ETC., ETC.

ELEVENTH EDITION.

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INTRODUCTION.

(*Creator and Cosmos.*)

The object of this volume, whereof the subject is the most stupendous and profoundly interesting that can occupy the mind, is to simplify (at least to the extent to which this can be done consistently with a fair development of the data appertaining to its illustration), the subject of the "Creator and Cosmos." To do this thoroughly and accurately is a work of great magnitude and gravity for the author, of great importance and consequence to the reader, and an accomplishment much to be desired by all lovers of the truth concerning this incomparably important and interesting subject. The treatment here, too, involving, as it does, the principal cosmical subjects in illustration, will assuredly be found as instructive as it is interesting, and will prove the verity of the old adage: "Truth is stranger than fiction."

In our day and country the demand for literature is very largely for the fictitious kinds of books which people obtain generally at a price about equal to their real worth—at a price which causes me often to seriously think how it is that authors (for, by the way, a writer of fiction is nothing short of a *bona fide* author, that is, originator or inventor), how it is, I say, that authors, authors of fiction, and their printers and bookmakers and booksellers can live. But they do manage to live and move; for a large class of the people will have such literature; and its visible supply upon the shelves is usually found fully equal to the (of this age) ever increasing demand. But even at the low price at which fictitious productions are sold in this age, it is a question whether some of them be not yet just that much too dear; some of them, I say, which, having a tendency to pervert the youthful mind and lead it into deceptive channels of thought, may thus effect it injuriously. There are large numbers of books of the fictitious kind which I would not regard as having any dangerous tendency, but which might be found both pleasing and profitable, as containing a good moral, to those who had leisure to occupy themselves with them. For me to specify such works, either individually or classified, by stating my opinions of them is, in my own opinion, inexpedient, and would, by others, be likely to be thought of as invidious.

My experience, however, shows me that in every community there is a certain number of thoughtful, sedate and reflecting minds, which will not occupy themselves with light or fanciful literature; these love the truth in whatever garb it presents itself to



them, be the language in which it is conveyed, on the one hand, so unpolished as to be fairly called crude, or, on the other hand, never so interesting, polished and classical. And, therefore, it is that I have read this work, which is an exponent of truth and fact, and altogether more strange and interesting than fiction, to be suitable to them, as well as it is to the general youthful mind. Is not this meet and right that it should be so? for the young people are always in quest of something which is grandly sublime in literature, and when they have met with a book which unites in itself the treatment of the ineffable grandeur and sublimity of the Universe with the solid instruction contained in the demonstrative illustrations thereupon, they are disposed to fall in with it in preference to all fiction.

This volume will be found to deal very thoroughly with the subject of the cosmical phenomena, in their various conditions, phases and aspects, physical, spiritual and moral, *the moral and religious world being illustrated from history, civil and religious*. It attends to the beautiful subject of the Creation in its relation to the Creator, showing the phenomenal world, or the world of sense, to be exponential of the Real and Invisible which underlies and is the Cause of it.

The varied discussion upon the subject of human language, etc., contained in the cosmical lectures, and elsewhere will throw much light upon the subject of the cosmical phenomena and their origin, and upon the subject of man and his descent, whether or not read in connection with my other treatises which may be called ethnological. These last are principally my works on Egypt; upon the Scots or Gaels, and the Scythians; my Chaldaean and Hebrew Origins, etc. As to the Cosmical Lectures at the end of this work, the third, that on the great pyramid, will be found so eminently cosmical, that a person would decide, having read it, a work on the cosmos could not be complete without it, and the fourth and last, which is "Proofs from Nature of the Existence and Government of God in the World," will be found to occupy its proper niche and to satisfy the mind upon points whereon it might think it had not had the requisite explanation in what had preceded.

In regard to the world of man, as well as the kingdoms of nature, animal, vegetable, mineral, etc., this work shows the relation of the past to the present, namely, of the prehistoric man and his works, the geologic species, etc., to the existing races, that is, so far as this is necessary to be done, in relation to this subject, and so far, perhaps, as it could fairly be expected to be done, considering that over three-fourths of the earth's surface prevents geologic or specific investigation by its being beneath the waters, and upon the one-fourth

that is dry the geologic and prehistoric research is as yet comparatively limited. The research into the prehistoric races of men and their ancient works, more especially as connected with the Western Hemisphere, which will be found in this volume, I myself consider of extraordinary interest and value.

In using the sciences for illustration in this volume, as Crystallization, Light Colors, Astronomy, etc., I found it both necessary and most to the purpose to illustrate the subject by the sciences themselves, their deductions and discoveries hitherto, which will be much more beneficial and satisfactory to the reader than the statement, here and there, of isolated facts and ideas derived from those sciences, their deductions and discoveries. The sciences as here, too, when viewed in their application to the Cosmical phenomena, are much more interesting and easily understood, than as set forth dryly in College text-books, wherein it is often found to be not easy "to see the point" of application.

Besides, I have treated of the scenery of the heavens as viewed from the planets and their satellites, a demonstration which is no more vague than are the practical parts in common Astronomy, and which makes the subject as here presented far more interesting than as set forth in the common treatises on that science, and exhibits the power, wisdom and glory of the Deity, as set forth in the scenes of existence, in a peculiarly interesting light. The astronomy, considering the way in which it is treated here, and the labor which has been expended in the demonstration of the scenery of the Heavens, I would consider worth, of itself, the price of the book.

The "Cosmos" of Alex. von Humboldt, which is, of course, a work of a different title than this, dealt mostly, not by any means exclusively, with the facts of the Cosmical phenomena as connected with the terrestrial system. It really did not take up and treat systematically the subject of the Cosmos proper, which certainly would involve Astronomy, Light, Colors and the Natural Sciences generally, in themselves, to illustrate it. No man need say that work is a substitute for this. Does this start you on the metaphysical bed-rock of the cosmical subject, ascending to the height and descending to the depth of that subject, while Humboldt's, in its way an excellent work, keeps you, as it were, playing with the pebbles on the surface? Does this give you a more absolute command of the whole subject than does his? Then, thank God for this; to Him be the Glory!

It will be well to remember that in the mathematical parts of this volume the English system of Notation is followed, which, where large numbers are dealt with, is considered to have more power than

the French system. The latter system is the one generally followed in this country, and which the author has followed in his Arithmetic.

To such as might be disposed to look upon this book with an eye of criticism, as those only competent by learning could be supposed to do, I may say that the work, consisting of Two Parts, was originally designed to form one whole, neither Part being then considered complete without the other, — but the changes which, since that time, have been made in and the additions which have been made to each of these Parts respectively, have, I consider, made each of them, as books, sufficiently full and complete in itself. The first volume, now, is properly on “Creator and Cosmos,” and is here completed by the Four Cosmical Lectures.

ST. LOUIS: 1889.

R. S.

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CREATOR AND COSMOS.

PART I.

EXISTENCE PHYSICAL, SPIRITUAL AND MORAL ILLUSTRATED FROM VARIOUS SOURCES IN THE PHYSICAL AND MORAL WORLD, AS FROM THE ANIMAL, VEGETABLE AND MINERAL KINGDOMS OF THE EARTH—THE EARTH ITSELF—THE PROBABLE PERMANENCY OF THE COSMOS AS TO PHENOMENA OF FORMS, CHANGES, ETC., BEING TO SOME EXTENT HERE ILLUSTRATED—AND FROM THE CIVIL AND RELIGIOUS HISTORY AND THE OBSERVATION OF MANKIND.

The Creator: Creation, the Earth's elemental conditions of existence, Matter and Spirit literally defined, etc.



THE SUBJECT whereof we here propose to treat is that of the "CREATOR AND COSMOS." In order to start properly in this treatment it is not only expedient but necessary to explain the meaning of these terms; first as to what is the literal definition of the word Creator, and, secondly, as to what is the literal definition of the word Cosmos.

The simplest general form of the Latin root Cre, from the perfect passive participle of which, viz., creatus, comes our word create, is in the different languages Cer, which shows it to be a contraction of the full Gaelic form Caethir,* which is the

* Gaelic Cruth; Welsh Creu; Armoric Croui to create; which, originally referring to form, shadow or apparition, suggest the idea of forming or shaping. The local name Croton in Italy was changed, according to Dionysius of Halicarnassus, into Cothornia; and Colgan says the Cruthni or Picti of Erin and North Britain were called Caetherni. The Gaels or Picts of the British Isles were of the same race as those in Thrace and Macedonia and in the countries bordering on the Mediterranean Sea: The name Greece as well as Crete is the same root, as is also the adjective great.

Welsh *Caer*, and thus pronounced, meaning a city, a house, a seat, a throne, a king or occupant of the throne, who is supposed to be the originator and accomplisher, through himself and his varied ministries, or secondary causes, of all the political, ethical and moral changes which take place in his dominions.

As the term is referred to the occupant of the throne of the universe the Creator is God, who is understood to be the originator and sustainer of the universe and who orders or permits all that happens therein.

The Hebrew verb *Bara*, which is that used for create in the first chapter of Genesis, has to some suggested the universal creation as in the sense of a "bearing" or "bringing forth;" but the C in the root *Cre* and the B in *Bara* as first radical, being commonly exchangeable with each other, suggests as truly the roots to be identical; that is, whether the proper sense of the creation of this universe be that it was brought forth, analogously to our idea of bearing or bringing forth in the successive generations of the kingdoms of nature; or that it was made in the sense of having been constructed according to a plan or the like. The word create, therefore, as we use it in reference to the origination of the universe, must contain the two ideas, as we conceive them, namely, that of making, as according to architectural plan; and that of bearing or bringing forth. You may speak, therefore, of God as the Creator of the universe in the sense of his having made it or in the sense of his having brought it forth out of nothing; and you are correct in either way; for the least reflection will show that in our idea of bringing forth the idea of making is necessarily involved. But God, we must bear in mind, is absolute, and has done those things referred to in his own way, whatever conception we may have of that way, or in whatever terms we may choose to express it. So God does now, creating as he does, bringing forth continually, even if it be the evolving of the new out of the old; and this, too, always and particularly according to a distinct plan. Order characterizes this universe and God is the principal of order, the principal from which arise all those orderly phenomena which we experience. The primary idea of the word *Cosmos* is order, and thus it will not be wondered at if we find the word *Cosmos* akin in its derivation to the word creator.

The term *Cosmos* (Gr. *Κοσμος*, root *Κοσμ*) means order. Its first root *Cos* is the ancient *Caes* for *Caeth* as *Cush* for *Cuth*. Its compound

form is the ancient Caesam for Caetham ; which last is an original full form for the name Adam. Besides meaning an individual man, Adam, being a plural form of Chaeth, means the race of Cuth or the race of man. And as Aedh or Chaeth means the sun, so the plural of that would mean the world, or Cosmos, as being made up of the earth and the celestial hosts. Moreover, as the word Adam means red earth, so it means the earth, considered as to the idea of rotundity implied to the ancient mind in the expanse of the earth on all sides from any standpoint toward the horizon; and also the rotundity implied in the open above; the broad expanse on all sides, from any standpoint toward every direction of the over-arching celestial hemisphere; the yawning chasm, or Casm.

The universe, however, when referred to either the earth or to the all, cannot be spoken of as a chasm implying any disorder in the phenomena; for the terrestrial species we know are types of natural order, as are the celestial hosts which begem the firmanent and exhibit the unvarying reciprocity of the terrestrial and celestial phenomena.

Cosm, therefore, has reference rather to the idea of open concavity implied in the expanse of the universe, as well as to the hosts of worlds occupying that expanse, rather in the idea of their concavity and *in the order in which they present their phenomena*, than to the idea implied in our word chasm.

The Creator and Cosmos means, therefore, God and the world; God as the principal and setter forth of order; the world and all its phenomena as the exponent of that principal: God as the real and invisible; the world as the phenomenal, the exponent of the real; God as the eternally unchangeable; the world as the changeable, according to the eternal principles of order. So far as to the definitions of the terms.

But the principal of order according to which we see everything working itself out or developing in the natural world suggests a governing principal of order everywhere present by which those results come about; and the way in which everything in proper conditions is true to itself; and in which all the phenomena are reciprocally true to each other as connected with the earth and the heavens from age to age indicates but the one governing and directing principal as underlying all. This is the infinite, invisible and omnipresent God, whereof all we apprehend or are cognizant of is

exponential. He is the primal cause who works as suits his plan and his pleasure through secondary causes also. The created elements all perform his will: "He even maketh the clouds his chariots; maketh the wrath of man to praise him; and walketh upon the wings of the wind."

The creator being, as said, invisible and infinite, is undefinable. He is present everywhere, even creating in us to will and to do of his good pleasure; being infinite he is not conceivable as any object or thing; but of his character we may have some conception from the endless diversity of his creations and operations in the physical, moral and spiritual spheres. For though the creator cannot be seen by the eye nor mentally defined, yet since his agency produces all the effects, which are produced in the world of experience his character may be somewhat understood and appreciated from a consideration of his works as the character of an artificer may be judged of from a consideration of the work he executes or the strength of an animal from the power it exerts.

Now, though the creator be evidently one in person and will, as indexed by the unity and harmonious operation of the cosmical phenomena, yet in him must be, in some way, a plurality of persons and wills, that is if we follow the understanding had of him by the writers of the Old Testament. There the name of the Creator is expressed in the plural Elohim (Elach-im, i. e., Chael-im), which from the meaning given to El among the Phœnicians, to Bael among those as well as the Syrians and Assyrians, and to Chael (plural Chælim or Chaelin) among the Chaldaeans would point to the hosts of heaven, the cael-estials.

Whether this plurality may mean a duality of persons in the Godhead in some such way as that the male and female in the sexes of the natural world or the positive and negative polar forces in the electric phenomena, etc., may be fairly conceived of them exponential; or whether it may mean a Trinity in some such way as that the male, female and their offspring might fairly be conceived exponential; or whether it mean a greater number than two or three, it is certain that the writers of the Old Testament express the name of God in the plural in the Hebrew language, as in Gen. 1, 26. where the expression is: And God said, "Let us make man in our own image, after our likeness," etc. So also the word Adam here in the original, and properly translated man, is plural (i.e. in full Chaedh-am, and means literally the people of

Cuth or Cush. These Cushites were not only called *Æthiopians*, that is, by transposition of the components, *Japhaeth-ites*, but also *Aegypt-ians*, which is the same root again transposed as *Gae-phaeth-ians*, and this is again the *Jacobites*. It might appear certain, however, that the writers of the Bible meant the Deity to be understood as existing in some way which we conceive as *Triune*, of which, for example, the male and female parents and their offspring would be in our mind exponential: For John in the first three verses of the 1st chapter of his Gospel says: "In the beginning was the word and the word was with God and the word was God. The same was in the beginning with God. All things were made by him and without him was not anything made that was made." And Paul, in his Epistle to the Ephesians III, 9, says in reference to the mystery of Christ: "And to make all men know what is the fellowship of the mystery, which from the beginning of the world hath been hid in God, who created all things by Jesus Christ." And in his epistle to the Colossians I, 15-16, Paul, in speaking of Christ, says: "Who is the image of the invisible God the first born of every creature. For by him were all things created that are in heaven and that are on earth, visible and invisible, whether they be thrones or dominions or principalities or powers; all things were created by him and for him; and he is before all things and by him all things consist." And in his epistle to the Hebrews I, 1-3, Paul says: "God who, at sundry times and in divers manners, spake in times past unto the fathers by the prophets hath in these last days spoken unto us by his son, whom he hath appointed heir of all things, by whom also he made the worlds."

What might be thought plainly implied in all this is a trinity in principle in the Godhead as is symbolized, for example, in the terrestrial mediæ, the liquid or water (father); the solid (soil-id) or matter (mater, mother); and the aerial (aetherial) or wind (cind, kinder, son and sun).* These, I say, might be thought exponential

* That water and father is the same root is plain to all philologists; as is also matter and mater or mother. So Cind or wind is the same radically with son and sun. In the

Khandogya—Upanishad

Third Prapathaka

Fifteenth Khanda

contained in vol. I of the "Sacred Books of the East," compiled by Max Müller, I read as follows:

1. "The chest which has the sky for its circumference, and the earth for its bottom, does not decay, for the quarters are the sides, and heaven its lid above. That chest is a treasury, and all things are within it.

of the triune principal underlying them, and of which the Cosmos is exponential. But it is not either implied or understood that these medial symbols are to be thought of as God and worshiped; for these are but *mediae* or symbols by means of which the subject of the incomprehensible God may be made to a degree comprehensible to our senses. It is the invisible and undefinable God that is to be worshiped in Spirit and in truth.

And yet, although God be incomprehensible and invisible, he is omnipresent, which necessitates that he be omnipotent and omniscient. By or in his son he creates all things. How remarkable and beautiful is the order with which the creations are repeated. "Generation passeth away and generation cometh: but the earth abideth forever." Eccles. I, 4. Notice the process by which the earth's soil is moistened. The waters ascend into the atmosphere from the surfaces of lakes, rivers, ponds, seas and oceans, and having passed hundreds of miles overland in the shape of clouds descend again in the proper places as it were through great aerial sieves. Thus the land is refreshed and all animate creation. Who can be so stupid as not to perceive design in this? Does not the water here in the course which it pursues in fulfilling its mission in creation clearly correspond among the *mediae* to the male parent,

2. Its eastern quarter is called, Guhu, its southern Sahamana, its western Ragni, its northern Subhuta. The child of these quarters is Vayu, the air, and he who knows that the air is indeed the child of the quarters, never weeps for his sons. "I know the wind to be the child of the quarters; may I never weep for my sons." Elsewhere in these writings all things are derived from ether or space, and all things, even water and fire, eventually return thereto.

The divine being represented as speaking in the same collection, *Sanatsugatiya*, vol. VIII, pp. 193-4, says: "I alone am your mother, father, and I too am the son. And I am the self of all this—that which exists and that which does not exist." That which exists is here taken to be 'what is present' and what does not exist to mean 'past and future.' He is again represented as saying: "I am woven through and through (everything). And my seat is free from old age. I am unborn, moving about day and night without sloth. Knowing (me), verily, a wise man remains placid. Minuter than an atom, possessed of a good mind I am stationed within all beings. (The wise) know the father of all beings to be placed in the lotus (—like heart of every one)." From page 54 of vol. 15 of this collection I extract the following: "From the Self sprang ether; from ether air; from air fire; from fire water; from water earth; from earth herbs; from herbs seed; from seed food; from food man; so that man is the essence of food." From page 184 as follows: "As a mass of salt has neither inside nor outside but is altogether a mass of taste, thus indeed has the Self neither inside nor outside, but is altogether a mass of knowledge, and having risen from out these elements vanishes again in them. When he is departed there is no more knowledge."—"That living soul is to be known as part of the hundredth part of the point of a hair, divided a hundred times, and yet it is to be infinite." "That incarnate Self according to his own qualities, chooses (assumes) many shapes, coarse or subtle, and, having himself caused his union with them, he is seen as another and another, through the qualities of his acts and through the qualities of his body. He who knows him who has no beginning and no end, in the midst of chaos creating all things, having many forms, alone enveloping everything, is freed from all fetters." *Svetasvatara-Upanishad*, Id. vol. 15, pp. 257-8. In the *Laws of Manu*, contained in the 31st volume of this collection, there is much nonsense especially as to ideas relating to castes.

as, in our experience, among the species? Yet all this is the work of God; work plainly with design of means to ends. And so also the masses of the people are in the prophetical parts of the Scriptures symbolized by the waters.

It is certainly true that people should not look for a greater miracle than this cosmos with its phenomena presents; a miracle which nothing short of infinite ability could have produced. The cosmos is indeed a stupendous miracle, including an infinity of stupendous miracles, which are constantly repeated in our experience and for which man is not able to give a reason. Instead, therefore, of being puffed up with pride, this ignorance of his in the face of such wonders for which he cannot account, in the face of his own existence for which he cannot give a reason, should rather tend to impress him with a due sense of humility and dependence upon the author and sustainer of this cosmos and his existence, whom though he cannot account for nor begin to fully explain, yet he is fully conscious exists.

In regard to the *modus operandi* of the creation of the world, considered as the globe of the earth or as an infinity of revolving globes, cycles within cycles in endless orders, we have no data from any source in which we put trust but one, namely, the Biblical account, to know how it took place. The simple statement in Gen. I, 1, — “In the beginning God created the heavens and the earth,” — gives no clue to the way in which the creation was accomplished. This represents the earth as created on the first day; what the heaven meant there, speaking literally and without reference to the firmament, not being quite clear. But not till the second day is the firmament represented to have been created; and not till on the fourth day were the sun, moon and stars created and placed in this firmament. The creations on the first, third and fifth days are represented as in connection with the terrestrial medial conditions and species; those on the sixth day refer to the same as well as to the creation of man. On the seventh day God rested from his work of creation.

It is, therefore, seen there is no account given in the Bible of the way in which the world, considered as the globe of the earth, or as an infinity of globes revolving in cycles within cycles, in what is called space, came into existence. And this leads us in speaking of the creation to attend particularly to the terraqueous globe on which we live; to the phenomena which the heavens present about

it and in relation to it; and to its own phenomena and those of its species. As I will farther on treat at length upon Light and Colors and Astronomy, etc., it is unnecessary here for me to speak of the undeviating regularity with which day and night, the seasons, cycles, etc., have come about to the earth and apparently to the heavens in all ages of the recorded experience. But, speaking in reference to the terrestrial species, the regularity with which they have come and gone in their seasons has always been a subject of wonder and remark; and no less has it been remarked that the phenomena of the earth itself remains from age to age generally the same. Hence, without undertaking to demonstrate as to when those general phenomena, terrestrial and celestial, which men have always experienced first came into existence, some have made what have been regarded as able demonstrations upon the subject of the probable permanency of the Cosmos as to its phenomena of forms, changes, etc.; that is, leaving the matter of the beginning and the ending of the cosmical phenomena wholly with God, who only knows and who only has had and will have power to create and to destroy at will, they have demonstrated the probable permanency of these phenomena as to forms, changes, etc., as far as this might be done from the basis of the historically known human experience. This, however, arose partially in consideration of the system of ideas put forth and theoretically advocated in the "Origin of Species" and other cognate works of Charles Darwin.

And, now, in regard to this idea of the probable permanency of the cosmical phenomena, as to forms, changes, etc., much might be said upon this subject in an interesting way and to the increase of the fund of cosmical knowledge. And as to the forms, changes, etc., I may say, that changes of place of the earth and the heavenly bodies, by what we understand as their motions, will be fully treated of under the head of Astronomy, when we shall have advanced so far in our treatise.

There are changes which refer to man as a free, intelligent and responsible agent, which will, of course, be sufficiently treated under the head of the moral cosmos, or in treating of the history of man variously, in this volume of my works for itself; and in the second volume, called "Cosmotheologies," for itself.

The changes, therefore, which I will particularly notice here will be chiefly those which we observe in the earth itself and in its species. In these latter all things happen in regular order according

to their kind; all species spring from their own seeds; and the seeds of all spring from their species, such is the routine, an unending and regular series of changes in the same species, each successive one like its predecessor. You plant the seed of corn in the earth, and it, in due time, springs up with an entirely different appearance than the seed; goes through a series of changes, all bearing an appearance different from the seed; within a certain time, after you have planted it, comes out on top again, elegantly housed in its case as a seed, an image of that which you have planted; and, as it were, says to you, "Behold me, whom you have sown in the earth; here I am again risen from the grave, in full life and youth; here I am with a great many of my kind in my company; behold me manifoldly multiplied!" Such a simple illustration will serve for the general vegetable kingdom; and, as for the animal species, which also come forth from their seeds variously after their kinds in an analogous way and manner, the same rule holds good, that they come forth according to their kinds.

Moreover, as to the change of the animal and vegetable species into those called inorganic, which pertain to the earth's crust, I may, for example, say, that when the trunk of a fallen tree or the body of a dead animal becomes mineralized or petrified, the component parts of the original form, combining with certain other elementary substances, a new form or species of existence is produced. Also, if it be understood that the matter of the earth assumed or was given its present globular form from its having existed, say in an aeriform or nebulous state, then that change of the matter into the globular form, or into that form which we understand as the earth, might be spoken of as the creation of a globe; but could not be spoken of as a creation of the material of the globe, considering that it had existed before in another state. A primal creation of matter and space, of forms and motions, of vegetables and animals, etc., is generally and tacitly granted in the absolute theological sense. By faith St. Paul accepts it as in his epistle to the Hebrews, ch. xi: 3, where he says: "Through faith we understand that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear." And in Ps. xxxiii, 6, it is said: "By the word of the Lord were the heavens made and all the host of them by the breath of his mouth." But the creation which we are now speaking of being the actual one; a creation which we understand to be effected by

and through him in whom we live and move, we conceive the species, for example, to be but conditions or means to their own perpetuation by the Higher power. And in reference to this, I may say, that however it may really be or might prove to be I have not yet been told that man has learned how to govern as to the proportion of the sexes, which may in any age exist within his own or other species.

And now in regard to the earth's crust it is seen that on the terrestrial surface and for a short distance below it, all things are continually changing; one form of matter taking the place of another in existences animate and inanimate. Animal and vegetable remains are changed into clay and rocks and water; and these again into the production and support, and into the composition of the solid framework of the organic structures of vegetables and animals. When the living or animate body dies it ceases not to exist; there being no such mental conception for it as annihilation. Death is only a sleep or state of unconsciousness of the body previous to its change into other organic or inorganic existences. Thus the chrysalis state of the caterpillar, in which that creature remains to all appearance dead, has been often compared to the state of the dead of the human race. But what happens to the caterpillar? At the end of a month it comes forth from its tomb, having gorgeously tinted wings and soars on high, a beautiful butterfly. We have yet to learn whether in its new and exalted state, it remembers its former humble condition of a caterpillar; but think it perhaps does not.

Speaking of the human body in particular, whereof seventy-five per cent. of the fleshy parts are water, I may say it is a kind of laboratory, in which a chemical process is continually going on of decomposition or decay and of recomposition for the supply of animal tissue; and, as it is said, that no two persons see the same rainbow, even so may it with equal truth be said that no human being has exactly the same body two days in succession. If the human body is, therefore, in every part continually undergoing change during life should it be matter for wonder or any ground for apprehension that there shall be a more radical change effected in it by death, a change from which a new and nobler creation shall arise?

Of the following piece of poetry the authorship has been by some attributed to Bulwer Lytton; but I think I may have been

credibly informed that it was written by a Mr. McCreary, who when he wrote it was living in Iowa. As it bears upon this part of our subject I quote it here:

THERE IS NO DEATH.

There is no death! The stars go down
To rise upon some fairer shore,
And bright in heaven's jewelled crown
They shine for evermore.

There is no death! The dust we tread
Shall change beneath the summer showers,
To golden grain or mellow fruit,
Or rainbow-tinted flowers.

The granite rocks disorganize,
And feed the hungry moss they bear;
The forest leaves drink daily life
From out the viewless air.

There is no death! The leaves may fall,
And flowers may fade and pass away —
They only wait through wintry hours
The coming of May day.

There is no death! An angel form
Walks o'er the earth with silent tread,
And bears our best loved things away,
And then we call them "dead!"

He leaves our hearts all desolate;
He plucks our fairest, sweetest flowers;
Transplanted into bliss they now
Adorn immortal bowers.

The birdlike voice, whose joyous tones
Made glad these scenes of sin and strife,
Sing now an everlasting song
Around the tree of life.

Whene'er he sees a smile too bright,
Or heart too pure for taint and vice,
He bears it to the world of light
To dwell in paradise.

Born to that undying life,
 They leave us but to come again;
 With joy we welcomed them the same,
 Except their sin and pain.

And ever near us, though unseen,
 The dear, immortal spirits tread;
 For all the boundless universe
 Is life — there is no death!

It may be expedient here to state that the principle of life is inherent in all matter, although it may be largely in a latent state. But every part of matter, even the solid rocks, the earths, the waters and the air, when examined with a microscope of sufficient power, is found to present signs of animate and sensitive existence. This instrument discovers to the view myriads of little animals in a drop of stagnant water, some of them so minute that, when viewed with a glass which magnifies one hundred thousand times, they severally do not appear larger than a visible point. And yet each one of these is a distinct being. If a microscope of high magnifying power be directed to the atmosphere on a calm, clear day in summer, shoals of animalcules may be seen in its undulations.

But the existence of life in matter and in every part thereof in the way of principle and in a latent state, independent of the appearance in connection with it of organized, sensitive existences may be proved by many and potent considerations.

All vegetables derive their nourishment from the earth, assisted by the atmosphere and the sun. Animals from these derive their nourishment. It is true the earth does not bring forth vegetables and animals spontaneously; if it did, then we might say they derived their existence immediately from the earth; these must spring from their peculiar seeds; but having been originated in this way, the earth and its accompaniments, the atmosphere and the sun, afford them increase of life and nourishment, which if matter did not contain it could not impart. All vegetables and their seeds return to the earth, whence they sprung, bringing their principles of life and vegetation with them, and become earthy matter. Also the bodies of all animals return to the earth, bringing their principles of life and generation with them and become part of the earth. These

very principles of vegetation, generation, and life, again enter into the production and support of other living beings, animate and inanimate. It is, therefore, seen that the same principle of life which exists in all living beings, animate and inanimate, exists in the earth, the atmosphere and the sun.

And not only is the principle of life inherent in all matter but also that of intelligence. This principle is perceived, as it were, in its germ in the lowest order of animals, and is brought to a fair degree of perfection in highly civilized and cultivated man. Between these two extremes there exist different grades and degrees of intelligence, but the fact of the existence of this principle in all animate beings is certain, and it needs only to be educed in order that it become apparent. But how is it to be educed in the case of the lowest order of animals, microscopic animalcules? It need not necessarily be educed in their case, for they naturally exhibit it unmistakably to observation. The following extract from Mr. Baker, a celebrated naturalist, in his description of the hair-like animalcules, will help to illustrate this:—"A small quantity of the matter containing these animalcules having been put in a jar of water, it so happened that one part went down immediately to the bottom while the other continued floating on the top. When things had remained for some time in this condition each of these swarms of animalcules began to grow weary of its situation, and had a mind to change its quarters. Both armies, therefore, set out at the same time, the one proceeding upward, the other downward, so that after some time they met in the middle. A desire of knowing how they would behave on this occasion engaged the observer to watch them carefully, and, to his great surprise, he saw the army that was marching upward open to the right and left to make room for those that were descending. Thus, without confusion or intermixture, each held on its way; the army that was ascending marching in two columns to the top, and the other proceeding in one column to the bottom, as if each had been under the direction of wise leaders." Here we have unmistakable evidence of voluntary motion and of a considerable degree of intelligence in these exceedingly minute animals.

The ancient Romans appear to have been aware of the inherent existence of the principle of intelligence from their use of the word *educare*, to educate, which means to draw out or develop that which already exists in principle within.* Many of the inferior animals,

* Locke, in whose Essay there is much commendable, appears shallow in his argument against "innate ideas," and refutes himself partly in his confession of the Existence of God and of intelligent invisible spirits. First, we cannot conceive of man, as such, devoid of the "Senses;" secondly, the infinite and omnipresent Being is *independent*, and the source of all knowledge. He knows infinitely more than man can possibly conceive, and can cause ideas to spring up in the mind.

when taught, display a remarkable degree of sagacity, and, although we need not necessarily believe what Cicero says as to Orpheus taming the wild beasts of the forest by playing to them on his lyre, yet we now-a-days have abundant experience of what the domesticated animals, such as horses and dogs, and many of the wild animals, such as lions and tigers, can be taught to do. As the rough, unshapen block of granite or marble from the quarry may be formed into the stately and beautiful sculpture, so resembling the living and animate being as to deceive us if not assisted by the sense of touch; as the rough block of iron ore may, by being put through a certain process of fusing, hardening, malling, etc., be reduced to the form of the sharp edged instrument, the sword, the knife, or the razor; as the telescope, which so wonderfully opens up to us the distant regions of the universe, and enables us to contemplate far distant worlds, as if they were nigh; and the microscope which enables us to investigate the races of animated beings, invisible to the naked eye, which exist in the earth, in the air, and in all matter, are made chiefly of such earthly substance, as sand and ashes— even so may the intelligence of all the inferior animals which are capable of being taught be brought to a much higher degree of development than that which it has yet attained;—even so may the intelligence of uncivilized human beings be brought to that state of development to which civilized man has already attained; and that of civilized man be brought to a degree indefinitely higher than that which we know of man to have yet attained. It is an old saying, and generally a true one, that what is in will come out; but it is more positively true that what is not in cannot come out; therefore, if the principles of life or intelligence were not inherent in matter there could be no life or intelligence developed from matter; but, since life and intelligence do exist and are developed amid such complex and multiplex changes of matter, it is plain that the principles of life and intelligence do exist, though in different degrees, in all matter, and that in proper circumstances they become apparent, and by proper development they become more apparent; but that the fact of their non-apparency in certain states and conditions of matter to an intelligent being does not alter the fact of their existence there in a latent state.

Uneducated persons are apt to suppose that the air they breathe is the principle of life; some, that it is the soul. This seems to have been the conception of it entertained by the ancient Hebrews; for the *Nephesh Hayya* of the book of Genesis is translated into our language the “breath of life” or the “soul of life,” but the truth is, the air only helps to sustain the animate being in life; it performs its part in supporting life, as food, the production of the earth, and

water,—which two elements are quite as necessary for animal support,—perform theirs. Air is the element which terrestrial animals breathe by means of lungs, just as water is the element which aquatic animals breathe by means of gills; alter the condition of these two great classes of animate beings and they could not exist as animals; submerge a land animal in water and it will very soon be suffocated; elevate a marine animal to the land, and he will as soon die. All these animals are produced by their kind, but, having been introduced to the world, they are supported by the elements to which they are naturally adapted. Not less than all these elements are necessary for their sustenance. The various tribes of aquatic animals are supported by different kinds of food which they find in the waters and on the bottom of the ocean, lakes and rivers, on rocks, etc. Many of these tribes, which correspond to the carnivorous species of the land, subsist by preying on other tribes; but water is the element in which they all live, which they breathe, and from which mainly they derive their support,—for sea animals do not depend for support upon the land, their own realm supplying all their wants. We may remark here that a very small quantity of air pervades all water and a small quantity of water in the condition of vapor pervades the atmosphere; and both these elements seem mutually to assist each other in the support of living beings, and to be adapted to each other's co-existence.

A man or any land animal may be in the enjoyment of an abundance of pure air and wholesome food, but if he have not a sufficient supply of water for his animal wants, he will die. Also, he may have an abundance of pure air and water, and, if he have not a sufficient supply of wholesome food, he will die. And, further, he may be furnished with a plenary abundance of both wholesome food and water, and, if he have not a copious supply of pure atmospheric air, he will languish and die. All these are indispensably necessary for his animal existence; but, with all these, his life would still be a peculiarly wretched one, if he could at all be supposed to exist, without the light of the sun. If the sun never shone upon our terrestrial sphere, the earth would be a dark, desolate wilderness; no vegetables could grow on it, and no animals now existing on its surface could live on it. Solar light and heat are necessary to the existence and growth of vegetables, and the vegetable kingdom, together with air and water, are necessary to the support of animal life. And can any one now say to which he is most indebted for the necessities and comforts of life,—whether to the products of the earth, to the air, the water, or the solar light and heat? Can any one now tell to which of these he owes most, or whether he is

a debtor to any one or all of them ? They all, it is seen, are mutually necessary for the support and existence of man. The answer will doubtless be that they are all necessary and good ; that this world is admirably constituted for the maintenance and accommodation of animate and intellectual beings ; that, in short, if the means and privileges which this world affords were rightly distributed among mankind, and used without abuse, our earth would be a terrestrial paradise, worthy the name of heaven below ; all would be happiness and peace among men ; no one would covet or wrongfully seek what did not belong to him ; each would be equally interested for the good of others as for his own ; but, since no one is responsible for having been born into the world, one should not consider one's self peculiarly indebted to it for the gifts and privileges it affords him, provided he has obtained and uses them aright.

It will be seen that the principles of life and intelligence are inherent in all matter not only from the preceding illustrations but from those that follow. In the processes of change earth becomes rocks and minerals, and rocks and minerals become again crumbled into earth. The earth produces the vegetables, from their seeds, vegetables become incorporated in animals from being their food, and animal and vegetable substances become incorporated in man from being his food. The vegetable and animal substances are earthy matter, including common clay, mineral, and metal, now temporarily in different states from that in which they exist in the solid earthy substances. But these animal and vegetable substances are continually undergoing change, and destined soon to return to the earth again, where they will still be undergoing change ; and one animal or vegetable body, say for example the body of any animal whatever, or a tree, when deposited in the earth, may give birth to thousands, yea, tens of millions of living beings ; and these countless beings ceasing to exist in their turn, their substances become earthy, which may give birth to other living beings, or go to the production and support of plants and animals.

But vegetables and animals do not consist altogether of earthy matter, properly so called ; the largest part of their substance is made up of water, another species of matter ; and also the atmosphere, light and heat, enter into their production and substance. But water, as we have intimated, is a material substance, and so is the atmosphere ; and light as well as heat is an everywhere present element, even in the dark and in the cold, only requiring the action of certain material agencies, or rather that matter be in certain conditions, in order that we become sensible of their presence. Light and heat are merely phenomena or effects attendant upon cer-

tain states or conditions of matter, conceived and named in this way, therefore, all existence is of a material nature. The names of many objects are arbitrarily given; but notwithstanding this the term matter, may not have been arbitrarily applied by our ancestors to the phenomena which bear that name. They may have had a natural reason for so designating those phenomena. The animal body is of the same material as is the mediæ in which it exists. The intelligent, rational being is conscious that his body is made up of such materials as earths, rocks, minerals, water, the principles of light, heat, etc., and some have denominated a human being an epitome of existence, material and spiritual.

To illustrate that the air is a material substance such things as the following might be considered: when a person runs against the wind he feels a force pressing him backwards, and the faster he runs the more is he sensible of its resistance. Though he is unable to see anything around him, yet he is sensible that something exists to press him back, for he experiences its effects. But a better illustration of its materiality is the following: that it excludes all other bodies from the space it occupies. Thus, if over a cork, floating on a vessel full of water, we invert a glass jar having a wide mouth, it will be seen that but a very small quantity of water can get into the jar, because the air of which the jar is full keeps the water out; otherwise if it were emptied of every material substance, the water would rush in and completely fill the jar. The cork, still floating on the surface, will show how far the water rises in the jar. On this principle the diver's bell has been constructed, an instrument in the shape of a bell, the use of which enables men to walk about on the bottom of the sea with as much safety as upon the land. The head of the diver being within this bell-shaped instrument, which comes down in ordinary cases nearly to his shoulders, is separated from the water, for the water cannot enter the bell except for a very short distance while the bell is filled with air. Fresh air is constantly supplied to the diver by means of an air-pump, situated on the land or on the deck of a vessel, and a tube which connects it with the diver's bell. In most cases there is a large diver's bell in which the divers descend, which connects directly with the air-pump by a tube, and in which a supply of air is kept for the divers, who have during their submarine explorations the small bells which they use connected by a tube with the reservoir of air in the large bell. Such an arrangement is necessary, for if air were not supplied the diver in sufficient quantity, he could not remain below for any length of time, as the air contained in the bell which he uses becoming very

dense by the pressure of the water and vitiated by his own breathing would become poisonous, and he would die.

And again, if we take a pair of common bellows, and, after having opened them, if we shut up the nozzle and valve-hole, and try to bring the boards together again we shall find it impossible. There is something included which prevents the bellows from coming together in the same manner as if it were filled with flax or wool; but on opening the nozzle we can easily shut them by expelling this something from within, which will issue with considerable force, and impel anything that lies in its way. This something is atmospheric air.

Also, air is not only material but wonderfully expansive and elastic. Thus, if a bottle, being put under the receiver of an air pump, is entirely emptied of its air, and in this condition being tightly corked is again introduced to the receiver, when the air is admitted to the receiver the bottle will be broken to pieces by the pressure of the air upon its outside, since there is nothing within the bottle to resist its pressure. Also, if a bottle full of air, and hermetically sealed, be put in the exhausted receiver of an air-pump, the air within the bottle expands, and, there being nothing on the outside of the bottle to resist its outward pressure, breaks the bottle to pieces. All which shows that air is a material substance and capable of expansion when in a vacuum or rarer medium. And that it is susceptible of compression when acted upon by a denser body is proved by the fact of the water having ascended a short distance in the jar and the diver's bell, although they were full of air; for no water could have entered them if the air they contained were as dense as the water. Air is so elastic that a quantity of it, as it exists at the earth's surface, can be expanded into nearly fourteen thousand times its original bulk; and the fact that it is elastic shows it also to be compressible, for whatever is elastic is capable of being compressed into a smaller space. Air is capable of being compressed into a small space compared with that which it naturally possesses.

There can be no difficulty, we think, in any one conceiving how that water is a material substance. Like air it is capable of great expansion. A cubic inch of water, when reduced to steam, occupies a cubic foot or over seventeen hundred times its original bulk. But it is with difficulty that water can be compressed into a space less than that which it naturally occupies. It is one of the first principles of natural science, that no two bodies can be made to occupy the same space at the same time; therefore, air is a body and so is water, just as much material bodies as stone or iron is. Fill a vessel full of water, and immerse in it any convenient solid, and a quantity of water will flow out of the vessel, exactly in proportion to the

bulk of the body immersed. When a vacuum or empty space is made by the removal of any body, solid or fluid, the air rushes in from all sides instantaneously to fill up the vacuum, just as water rushes in from all sides to fill up the vacuum which is made by the taking of a pail of water from a reservoir, and as the vacuum which is made by the rolling of a wave on the surface of the ocean is instantly filled up by another wave rolling into its place, which undulatory activity is continued until the air becomes calm and the water level. The partial vacuum which is made at any place on the earth's surface by the expansion of the air by heat is instantly filled by the denser air from all sides rushing in to effect equilibrium. Such is the way in which winds are caused; the air at certain parts of the earth becoming rarified by heat, the denser air from other parts comes in rapid motion to fill up the partial vacuum thus made. Thus, we have, during a great part of the year, strong north-east and south-west winds, which are caused by the colder and denser air of the north and south polar regions coming in rapid motion to fill up the partial vacua which have been caused by the rarefaction of the air by heat in the equatorial regions.

All the spaces intervening between the heavenly bodies are occupied with air of a greater or less density. In some places it is dense, as at the surface of the earth, where, as we have said before, a quantity of it can be expanded into fourteen thousand times its original bulk; and in some places it is rare, as on the tops of high mountains and in the upper regions of our atmosphere. In the spaces intermediate of the heavenly bodies it is reduced to an exceedingly thin fluid called ether; but in no place is it wanting in sufficient weight and density to counterbalance its surrounding elements, for all existing things are naturally in equilibrium, and when there is any disturbance, as by a vacuum, they tend to equilibrium.

Thus, the atmosphere within the sphere of the earth's attraction is attracted to the earth's surface, and revolves with it round the sun, just as all the other bodies on the earth's surface are drawn towards its centre, and revolve with it in its diurnal and annual journey. The atmosphere, which is beyond the sphere of the earth's attraction, is either attracted by others of the heavenly bodies within whose spheres

* A vacuum is a place from which all the air has been withdrawn; a partial vacuum a place from which part of the air has been taken. A vacuum cannot exist in the universe except it be an artificial one, such as that in the upper end of a barometer, called the Toricellian vacuum, from Toricelli, the inventor of that instrument, which is considered the most perfect vacuum, and that in the exhausted receiver of an air pump.

of attraction it lies, or it exists in the intermediate spaces in the form of ether, where it is not subject to any sensible attraction from any of the heavenly spheres.

The atmosphere which surrounds the earth is analogous to the ocean of water which covers three-fourths of its surface; which atmospheric ocean, as the ocean of water, revolves with the earth, and in the bottom of which, we, with the beasts and birds, exist, as do the aquatic animals, in their own element.

The expansibility of the air and water by heat is exceedingly great; and not only these fluids but the densest and solidest substances, such as rocks and iron, gold, platina, and iridium, the densest and heaviest metals with which man is acquainted, can be reduced to a gaseous or aëriform state by the application of sufficient heat. Heat has the power of penetrating all bodies, and the greater the amount of heat enters any body the more the body will be expanded. Thus, a certain degree of heat will reduce ice to water, and a certain additional amount will reduce the water to steam, which is an invisible gas. Fill a bladder about half full with air and bring it close to the fire, and the heat entering the bladder will expand the air until it bursts the bladder. Fill the bladder about quarter full or put a still less amount of air in it, and leave it for a sufficient length of time before the fire, and the air will expand as before and burst the bladder. A like result also would happen to aëronauts if they should be carried so far from the surface of the earth as that the air in their bodies would be much denser than that by which they were surrounded; the air inside their bodies would expand, seeking equilibrium, and burst their bodies. Yet this will scarcely ever happen, we think, for the hydrogen gas with which balloons are filled, though lighter than the air at the earth's surface and for some miles above it, will not ever suffer the balloon to ascend into a very rare medium. The air contained in an apple can be expanded by heat to such a degree as that it will fill a space more than forty-eight times the dimensions of the apple. Take an iron bar whose end when cold fits exactly into a hole, and when you have heated it red hot you will find it too large to enter the hole. Heat it more intensely and you will reduce it to the state of a fluid, and apply a sufficient additional heat and you will reduce the iron to the state of a gas. You may take a similar process with gold or platina, iridium or any other solid substance in the earth,* and attain the same result. This process of the reduction of solids to gases applies to all bodies in the earth; they are all ultimately reducible to a gaseous or aëriform state

* See, for example, "Comstock's Chemistry," or almost any other treatise on Chemistry as to this. Also, see Cassell's "Popular Educator," vol. ii. page 1.

by the application of sufficient heat. It is therefore theoretically though not practically true that the whole earth is of a substance reducible to the form of gas or air. If it were practically true, which does not appear to be the case, we might not be sorry if there should be a residuum after the reduction of our sphere to an aëriform state, which we, had we the good fortune of being removed to other scenes of existence, might use as material for making telescopes and microscopes to open up to our view the still distant regions of the universe. But gas means air, and air means spirit, and spirit means breath or that which we breathe; the whole earth, therefore, on which we dwell, with all that is connected with it, is spirit in a condensed form. In fact all the heavenly spheres, as we shall make plain hereafter, are of the same character, namely, condensed spirit, and the greater the amount of spirit condensed in a given sphere the greater is its power of attraction, just as the greater and stronger the mind of a man is, provided he uses it aright, the greater is his power to govern the minds of others.

There is a natural constitution and order of things in general, a state in which they tend to remain if not acted on by forces external to nature, none of which we conceive or by the art of man. Thus, the atmosphere will remain in its natural or normal state, and so will the sea and the solid land, if not operated on artificially by man. The extent of his operations on these elements is, however, very limited. He may reduce water and some solid substances to air, and he may reduce air, as carbonic acid gas, to a solid form; but all these will ultimately return to their natural condition, and the general condition of the atmosphere, the waters and the earth, will remain the same, notwithstanding all the change which man can effect in them. When therefore things are altered from their natural state by man's art, the process may be explained upon the principles of excess and deficiency of spirit. For example, water in its natural state occupies a given space, but being reduced to the form of a gas, or steam, it occupies a much greater space. But how has this great expansion been effected? By the penetration into the substance of the water of an additional substance called heat,* which expands it or assimilates it to itself; for although heat, as light and electricity, is an everywhere present substance, yet in its objective action it has to proceed from certain centres. The water in its natural state has its proper amount of heat, but when reduced to an aëriform state it has heat in excess.

* This penetration and expansion may not necessarily be interpreted to mean that any, the smallest amount of substance from without itself enters the body that is heated; but it does mean that the ultimate elements of the body have been set in motion by impulse of body from without; and it is easily understood that the elements in motion moving upon each other take up more space than at rest, and thus expansion.

And conversely, when iron or any other solid is subjected to intense cold it contracts, because of the abstraction of some of its normal heat by the surrounding elements ; in this state it possesses heat in deficiency of its natural amount. All substances are expanded by heat and all, excepting water, are contracted by cold. Water expands by freezing about the $\frac{1}{4}$ th of its natural bulk ; so that becoming lighter it floats on top, thus permitting the streams to flow under, which had not God so arranged, should in cold climates cover the countries with ice. Every one knows how his body and limbs swell, how his veins puff out, when he is much heated by severe exercise. One may also observe how his body and limbs contract, how the veins disappear, and how lank and meagre he is in comparison, when he is subjected to severe cold. In the one case he has heat in excess of his natural amount, in the other he has it in deficiency.

But things as naturally constituted may also be explained on the same principal of excess and deficiency of spirit, only by way of comparison. The air, the waters, and the earth, tend as we have before said, to remain in their natural state. The more solid or dense a body is, the more matter or spirit, which here means the same thing, does it contain. The solid earth, then, with its internal contents, minerals and metals, is evidently denser than water, and water is evidently denser than the atmosphere, and the atmosphere which surrounds the earth is denser than the ether which lies in the spaces intermediate of the heavenly bodies. The globe of the earth, therefore, land and water, in the given space which it occupies, comprises much more matter than the atmosphere does in the space which it occupies as compared with that occupied by the earth ; and the earth's atmosphere may be said to comprise more matter than does the ether in any part of the universe, taking space for space. Thus, the solid parts of the earth may be said by comparison to have matter in excess of the fluid parts, taking equal spaces, and the waters to have matter in excess of the atmosphere, taking equal spaces ; and the atmosphere to have matter in excess of the ether, taking equal spaces. And, conversely, the ether may be said, in like manner, to have matter in deficiency of the atmosphere, the atmosphere in deficiency of the waters, and the waters in deficiency of the solid parts of the earth. The earth, therefore, is the great concentration of spirit to which all things else tend that are within the range of its attraction. It is denser towards and at its centre than near or on its surface, and all things on its surface and its atmosphere are attracted towards its centre. And it contains in itself that power by which it moves, but it is confined to a certain course by the attraction of a weightier body, the sun, or other heavenly bodies.

The same power of penetration belongs to electricity and light as to heat. Light, heat, and electricity are all the same substance, under different modes of action and manifestation, or, rather, we may call electricity the element of which light and heat are peculiar phenomena, or modes of action. They are always found together when means are employed sufficiently sensitive or delicate to detect them, and all three are capable of producing a number of effects of precisely the same character in every respect. They are all three capable of penetrating all other bodies with which man is acquainted; they are all three capable of dispersion by means of conduction or radiation; and they may all be accumulated and concentrated or intensified in their action. Thus electricity is capable of being diffused by means of light, and also by means of heat; that is, if electricity be accumulated or intensified in its action at any point, and light and heat only be given off from that point, it is found that the electricity is dispersed although no current of electricity proper has flowed from the point. And, again, if light or heat, either or both, be applied to any point, a current of electricity can be educed from it; all of which goes to show that light, heat, and electricity are one and the same substance under different modes of action and manifestation.

Magnetism, also chemical action, motion and gravitation are modifications of the same general substance, or effects of the same agency. That magnetism produces motion is the ordinary evidence we have of its existence. In the magneto-electric machine we see a rotating magnet evolving electricity; and the electricity so evolved may immediately after exhibit itself as heat, light, or chemical affinity. Faraday's discovery of the effect of magnetism on polarized light, as well as the discovery that change of magnetic state is accompanied by heat, point to further like connections. Moreover, various experiments show that the magnetization of a body alters its internal structure; and that conversely, the alteration of its internal structure, as by mechanical strain, alters its magnetic condition. From light, also, it is seen may proceed the like variety of agencies. The solar rays change the internal arrangement of the parts of particular crystals. Certain mixed gases which do not otherwise combine, combine in the sunlight. In some compounds light produces decomposition. Since the experiments of photographers have drawn attention to the subject, it has been shown that "a vast number of substances, both elementary and compound, are notably affected by this agent, even those apparently the most unalterable in character, such as metals. When a daguerreotype plate is connected with a proper apparatus "we get chemical action on the plate, electricity circulating through the

wires, magnetism in the coil, heat in the helix, and motion in the needles." The production of all other modes of force from chemical action scarcely needs mentioning. The ordinary accompaniment of chemical action is heat; when the affinities are intense, light also, under fit conditions, is produced. Chemical changes, involving alteration of bulk, cause motion both in the combining elements and in adjacent masses of matter; witness the expulsion of rocks by the explosion of gunpowder in blasting. In the galvanic battery electricity results from chemical composition and decomposition; while through the medium of this electricity chemical action produces magnetism.*

Science has hitherto discovered 62 or 63 natural elements, which enter into the composition of our earth and atmosphere, which it denominates simple or uncompounded, and which it thus classifies: Three permanent gases, oxygen, hydrogen and nitrogen; four elements having many similar characteristics, chlorine, bromine, iodine, and fluorine; five solids not possessing the usual metallic properties, such as metallic opacity and lustre, carbon, boron, selenium, sulphur and phosphorus; fifty metals, only one of which is a liquid, namely, mercury, or quicksilver, all the other metals being solid. Of these it is generally considered that all known things are constituted, and the names given to these simple substances, on account perhaps of their peculiar properties, distinguish them from one another. But it may not be necessary to understand any more than two elements in nature which we may call by the old names, electricity and carbon, the latter substance representing the solid parts of existence, the former the fluid or gaseous; and the time will come, and perhaps is not far distant, when scientific men will conclude that there is no necessity of understanding any more than one substance to be in existence, which we shall call spirit, or leave unnamed, and of which all the varieties and diversities met with in nature are but modifications and phenomena. Nor may they think it necessary to limit the number of these modifications to sixty-three, or to put any limit whatever to that number; for the number of modifications in nature, as existence itself, is infinite.

But let it be remembered that, though all these so-called simple substances are but modifications of the same general substance, yet the knowledge and classification of them, after such a manner as has been in vogue by scientific men, may not be without its use. If it may be employed in the arts for the abridgment of human labor, for the prevention of human suffering, or for the supply of human wants

Prof. Grove considers all the so-called forces as certain affections or molecular polarizations of matter and not entities. Thus, motion in itself is nothing, being only body changing place. Heat being a mode of motion is not, as the old theory supposed, a fluid, but simply an affection of matter, and so of Electricity and Light. Magnetism, in itself static, can only manifest its force by the magnet being moved towards the body it is to attract. Chemical affinity

and necessities, conveniences or comforts, then it is useful ; but, if it be employed in the arts which minister to the detriment of human beings, so far it would be better not known nor practiced. There are no men who should be more candid, more interested in the welfare of mankind, or more active and industrious for the amelioration of the condition of human beings, than learned and scientific men. They are in the possession of that of which the great mass of mankind are destitute, which, if they use aright, will doubtless prove a blessing to their race, but, if they abuse or neglect, will prove a detriment and an injustice. Such men should remember that they have a trust committed to them, for the proper use of which they are responsible to their Creator, but for the abuse of which they will suffer the consequences in their own experience. Men feel all the happier for being good and doing good, yea, all the good they possibly can. Let each one of our readers remember this.

But the great mass of mankind, although unacquainted with chemical science or natural philosophy, have yet enough of common sense and sound judgment to guide them in their use of natural objects. Nature is a good guide, if they will but give sufficient attention to it, observe its laws and live according to its dictates. Surely most men know that matter is continually changing, undergoing new modifications, and entering into new combinations ; and that a material substance which in one state would be healthful, in another state, would be a rank poison. No man in the use of his senses and reason would choose to live in a place surrounded by unwholesome air and noxious gases in preference to a healthy place where there is an abundance of pure air, yet we find thousands in the rural districts, and even in large towns and cities, who erect their houses on the edge of marshes, and in the bottom of valleys, environed by hills, where they are surrounded with pestilential effluvia, carbonic acid gas and other gases, instead of on the brow or summit of a hill, where they will have the advantage of wholesome air. Neither would he choose to drink unwholesome pool-water in preference to the limped water of the running brook or the springing well ; nor, in preference to this last, would he consent to use such productions of art, as champagne or claret, whiskey or rum, gin, ale, beer, porter, and such like intoxicating drinks, although a great many who, in other respects, seem to use right reason are weak and silly enough to make use of such beverages. If a man who sleeps in an ill-ventilated room does not know scientifically the cause that is producing the weakness of his system, it may interest him to be told that, in breathing the confined air during the night his system has absorbed its nutritive properties, and has left only that part of it which is not fit to be breathed, which is tech-

manifests all these forces, as motion in mutual attraction or gravitation, heat, light, electricity and magnetism. He admits he can know nothing as to the creation or annihilation of matter ; that causation is the will, creation the act of God. The idea of Dr. Hickok in his "Rational Cosmology" acc. to which "matter is force" is, perhaps, in general, not very different from that of Prof. Grove.

nically called carbonic acid gas, and which, if it continues to be breathed, will cause suffocation and will ultimately cause death,—he, then, will be likely to conclude, whether scientifically or not, that he needs a constant supply of fresh air in his sleeping apartment. But there are few men so stupid as not to know, even though they may not be acquainted with one of the first principles of chemical science, that they stand in need, day and night, of a constant supply of fresh air. Without any knowledge of chemistry, the coal miner knows that he needs a constant supply of fresh air in the mine or that he cannot work there (and here it is proper for us to remark, since the vital interests of a large class of human beings are at stake, that it is the duty of the proprietors of coal mines, and of other mineral mines, to provide that the mines be supplied with a copious supply of fresh air, and otherwise kept as safe as possible, and that there ought to be superintendents of mines appointed by government whose care it should be that these things be done). Coal mines are usually supposed to have two shafts reaching from the surface of the earth to the bottom of the mine, into one of which air is impelled by means of an air pump, which air traverses the whole length and breadth of the mine, penetrating all its departments and recesses, and enabling the men and animals there to prosecute their employments. At the bottom of the other shaft a fire is kept burning, which rarifies the air now vitiated and impregnated with noxious gases after traversing the mine, and causes it continually to ascend through this shaft. It will be remembered that air rarified by heat always ascends. In some of the coal mines of Pennsylvania, in which such appalling accidents have happened of late, we have learned, whether it be true or not, there are some that know, that there was only one shaft used for the access and escape of air to and from the mine.

Experience will teach men, if they will but observe, that the air in deep wells, in cellars, in close rooms, in caverns, in marshes and low places, as well as in the upper regions of our atmosphere, is unfit to breathe and detrimental to health; and how bracing and wholesome is the air upon the elevated surface of the earth, and in all places to which it has free access, or which are kept well ventilated; how the air inside a building which has become vitiated by the breathing for a long time of a large assembly of people is not by any means as wholesome to breathe as the pure out-of-door air; how that the water contained in marshes and stagnant pools is not fit to drink, and how that contained in the running brook or springing well is wholesome and refreshing; how that the piece of flesh or other article of food which when fresh would be wholesome and nutritious, when undergoing decay would be a rank poison.

The hungry man does not stop to enquire whether the loaf of bread he receives is a compound of a number of simple substances, or whether it is but one substance. He takes it for granted that it is wholesome, and does not suspect that it contains any noxious properties. The use of a similar substance before has given him experience to know that it is just what he wants to satisfy his appetite. He knows, very probably, that it is made up of flour, water, yeast and salt; and it may not interest him to learn that the component salt is itself a compound of chlorine and sodium; that the yeast is composed of carbon, oxygen, hydrogen, and nitrogen; that the water is composed of oxygen and hydrogen; and that the flour is the product of the albumen of the wheat or other grain, which is itself made up of carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, &c., and that the whole loaf, if he can spare it, may be reduced to the state of a gas or air by the application to it of sufficient heat. He, probably, in his hungry state is not interested to know whether the egg he receives is but one simple substance, or that science has determined it to be made up of 55 parts carbon, 16 parts nitrogen, 7 parts hydrogen, and the remaining 22 parts, out of a hundred into which the egg is supposed to be divided chemically, are made up of oxygen, phosphorus, sulphur, &c., and that it, as the loaf, can be reduced to the form of an invisible gas by heat. But if he received that loaf or egg in a mouldy or decayed state, his reason or common sense would at once suggest to him that it would be injurious to his system if he ate it. He probably does not know, nor is interested to learn, whether the piece of flesh he receives is one simple substance, or whether it may be compounded of many simple substances, as carbon, hydrogen, nitrogen, oxygen, sulphur, phosphorus, &c., which chemical science determines it to be. He takes and uses these without hesitation, knowing from past experience and daily observation, that they are just such food as he needs. But if he receives these in a decayed state he would not use them, experience also telling him that in such a state they would do him hurt. Good common sense, therefore, accurate observation of the operations of nature, and the experience which is derived from the varied scenes and associations of life, seem most of the knowledge that is necessary for men to be possessed of, provided they use them rationally, in order to their well-being. It is, however, desirable that men should become possessed of all the knowledge they can, whether in relation to science, or art, or the affairs of life or any other branch of knowledge which may administer to their happiness and well-being. But even here common sense and reason should guide them in the selection of the branches of knowledge

which they should pursue; those should be selected which are most necessary, and undertaken and pursued with a good and useful end and object in view. Time, for example, spent in the study of some of the dead languages and of some other branches which are never reduced to practical use, if these studies be not pursued merely as a discipline for the mind whereby some good may be derived from them in that sense, is time lost. That time might be well and usefully spent in a practical way, or in the study of those branches which could be reduced to a practical use for the benefit and well-being of the person's self and of mankind. And not only the person's own benefit, but that of mankind also should be kept in view, in the selection and pursuit of any branch of study. The knowledge of chemistry, we allow, may be made of great use to mankind, if employed by those who become possessed of it for the benefit and highest good of mankind, and not, as in many cases it is, for their detriment. What shall we say of all these poisonous luxuries that adorn the tables of the rich, and which owe their existence to chemistry? Or of gunpowder, which chemistry informs us is made up of nitrate of potassa, carbon and sulphur, in specific quantities?

That the phenomena we call matter have never not existed,* will become more apparent as we proceed and is the opinion now most generally entertained among the learned. But that change has always taken place in matter, that the earth and the heavenly bodies have always been as to their forms and motions the same as they are now, that mankind has always existed as to general form and appearance much as he in general exists now, that the universe has always presented to the eye of man, in general, the same phenomena as it does now, that it has always been to him a present thing,—a thing, we say, so far as it came within his view or could be conceived by his mind; but as to its being wholly conceived by his mind, nothing; of all this, although we do not necessarily assert the positive, preferring to leave people to judge for themselves concerning these matters from the arguments which we shall afterwards adduce, we may assert that there is no valid evidence to the contrary. (†)

The only conceptions which the mind of man can form are of objects or things. Objects or things are limited or bounded, they all

* If that which, by any means, we can neither create nor annihilate, is asserted to have been brought into existence in some way called creation, it may and often is consistently asked, how has that space been created which matter occupies? If inquiry is necessary concerning this subject, the creation of one of these is as much a subject of inquiry as that of the other.

(†) See examination and comparison of the accounts of the Creation in the book of Genesis in the beginning of Part Second of this book. To these accounts, or to the hypothesis of "evolution" which has for its base the "Nebular hypothesis," they may refer who are not content with creation as it actually takes place.

have a beginning and an end, a limit in every direction. But the universe being infinite, that is, without beginning or end, or any conceivable possible limit in any direction whatever, is no thing, no object: it is *nothing*. This may be better understood from an illustration. Take a line, (which is necessarily an imaginary one,) and beginning at any given point, say the centre of the table before you, conceive of it as extended upward toward the Zenith, or straight above your head; or right downwards toward the Nadir, straight beneath your feet; or towards the East, West, North or South, or in any other direction whatever, toward any point of the celestial sphere; conceive of this line as extended for any length of time, say for a thousand millions of centuries, and at any rate of rapidity of extension, say ten thousand millions of miles per second; let it be conceived of as extended for any length of time, and at any rate of rapidity whatever, and it can never be conceived of as coming to a termination in any one direction, so that it cannot be conceived as being capable of being extended further. It is as near such a termination in any direction where it ceases to be extended, as it is at the central point of the table from whence it began to be extended. And that central point, too, of the table, which we have used for convenience of illustration, we do not conceive as having either beginning or end: it is infinite and nothing. Here then is the idea or the no idea; the universe everything and nothing; a point infinite and nothing.*

The human mind, as we have stated, can conceive only of objects or things. A man is an object, a tree is an object, the earth is an object, the moon is an object, the sun is an object, the planets and stars are objects; and everything that has or can be conceived of as having a beginning and an end, a bound in every direction of space, and everything that has or can be conceived of as having a beginning and an end in time, is an object or thing. In fact the universe, so far as it can be conceived by the mind, is an object or thing; but considered as infinite it is nothing.

This illustration of infinitude and finitude will throw some light upon the statements we have made in the opening page of this book, as to the Creator and Creation. Is it not very plain that our omnipotent and glorious Creator, that is infinite, cannot be conceived by the mind, much less seen by the eye? And yet men are so unrea-

* If any one will consider for a moment upon this subject he will realize that, in a sense, he is infinite. The thought starts from his own mind, and, like Noah's dove, sent forth from the ark, can find no resting-place in any direction whatever until it return to his own mind again. In the mind it has the beginning and the end. If the mind could reach a limit in any direction whatever so that it could not conceive further, he would be finite, not infinite.

sonable, so presumptuous, as to set up material objects as representations of Him, and worship them; and invent systems of ideas which they call systems, or "bodies" of divinity, and set them up and worship them instead of Him. For how is it possible to conceive of an Infinite Being? The mind can form no idea of Him, and how absurd and blasphemous that men should worship objects and things such as the sun, moon and stars, idols of wood and of stone, and men living and dead of their own race! It appears so absurd and blasphemous as scarcely to be tolerable. And yet we are sensible of the presence of our great Creator, and can see His character reflected in every natural object. How important it is that men should be good and do good, and maintain an humble and devout spirit in His presence?

It is plain that the distinction between objects and things and nothing, or, in other words, between the finite and the infinite, arises from the different states and conditions of matter as to density and rarity,—an idea which perhaps will be understood from the explanation we have already given of it, and may be more clearly understood from what follows: If all the matter in our globe and in all the other bodies in space were reduced to a gaseous or aeriform state, all of the same density, which reduction we have shown to be theoretically possible, there could be no object or thing in the universe: nothing but space which we can now conceive would exist. We might conceive of space to no end, but there would be no proper object to be conceived by the mind. Matter considered in the form of our earth or of any other globe, or even of Saturn's ring or of any other form, is an object or thing, and the condition of its being a definite object depends upon its existing in that condensed form to distinguish it from other forms of matter. Hence partly arises the numberless objects which are in and on the earth, partly we say, for some objects are distinguishable from others by their difference of density, some by their difference in form, and some by their difference of color, etc.; for there is such a diversity in all these, and in other respects, that scarcely any two objects in all nature are exactly alike in every respect. This will be better understood from illustrations which we design to give further on. Hence it may truly be said that the earth exists out of nothing, also the sun, moon and stars, and each of the other heavenly bodies which do exist in the universe; each of these bodies, however large, is a definite object or thing, and each of them may be said to exist out of nothing; and, if all were reduced to an aeriform state of the same density throughout, they would cease to be definite objects or things and would vanish into nothing. Hence too, may have arisen the notion entertained by the ancients, of the

earth and the heavens having been created or caused to exist out of nothing in six days, a notion which has descended to our time, but which of late, since the researches of geologists and astronomers have shed a glimmer of light upon the subject, has been discarded, or rather the subject has begun to be understood differently—understood in such a way for the sake of accommodation, perhaps, that the six days are made to represent six long periods of time. And what, do we guess, will be the next step which theologians and all godly men will take with respect to this subject. Why they will be happy to confess that for what they know to the contrary the globe on which we dwell as to its essence and present general form may have never not existed; even thus they may look at it now, leaving the perfect understanding of it to God alone. The doctrine of the creation of the cosmos out of nothing, as it has been taught and believed, has been the cause of a great deal of superstition, and indeed a particular inconvenience and impediment to progress, in the right direction. Not the old creation of Genesis but the new creation of John should be held out as of any importance for men to believe in; not a creed of miracles which are only properly understood by a few, or of traditions which as commonly and literally understood are nullified by their inconsistency should be held forth as of importance for men to accept by the teachers of mankind. They should teach men to be good and to do good individually; to live lives of self-denial, of holiness and righteousness, of charity and of honest industry: they should teach men to depend for happiness and peace upon their own godly living, and not to depend for immunity for their own misspent lives, their lives of impurity, of vice and wickedness, upon the virtues of any other. They should practise this doctrine of regeneration themselves, and let their lives of humility, of industry and of godliness be conspicuous examples for those they teach to imitate. They should not teach men to expect the millennium, except men themselves, by their godly living, bring it in; and they should do all in their power in the state, in their own narrower sphere, and in the improvement of individual life, to introduce and perpetuate that glorious era.

That the cosmos as to the phenomena of forms, motions, &c., has never not existed while there is no evidence definitely to prove, as it is impossible for us to conceive infinite time any more than infinite space, there is, as we have mentioned before, no evidence to disprove. While men have no knowledge of its having existed even essentially in any other way, say for example, in a nebular state, as the nebular hypothesis, which we shall speak of, by and by, and which is only an hypothesis, assumed, yet they have definite knowl-

edge for long periods of time, of its having existed in the present general way, as to phenomena of forms, motions, &c. Although Astronomy was cultivated by the ancient eastern nations, especially the Babylonians and Egyptians, for thousands of years before the Christian Era, yet Thales, a Milesian, whose date is 610 B. C. was the first we know of, to have recorded an eclipse; and astronomers of the present day tracing backward the eclipses to his time have determined his record to be correct; and also that the earth, moon, sun, and planets have performed their revolutions during that period with *undeviating regularity and precision*. Therefore, tracing backwards in the same manner we shall find that we have no right to infer that as to the phenomena of forms, motions, &c. they ever existed in any other way than as in general, they do now, or that their substance assumed such forms, motions, &c., from having existed previously in any other state, since we have no evidence for any such conclusion and are not necessitated to point an assumption from which to draw any such inference, which would be heaping one hypothesis upon another. The compound ring of the planet Saturn is a body of such immense dimensions that it is computed to contain an area of more than one hundred times that of our globe, and to revolve around that planet at an exceedingly rapid rate of motion, namely, 900 miles a minute. It is found to be not exactly concentric with the body of Saturn, and, therefore, must subsist about that planet in a state of unstable equilibrium. "The observed oscillation," says Sir J. Herschell, "of the centres of the rings about that of the planet is, in itself, the evidence of a perpetual contest between conservative and destructive powers, both extremely feeble, but so antagonistic to one another as to prevent the latter from ever acquiring an uncontrollable ascendancy and rushing to a catastrophe. The smallest difference of velocity between the body of the planet and the rings must infallibly precipitate the latter on the former, never more to separate; consequently their motion in their common orbit round the sun must have been adjusted to each other by an external power with the minutest precision, or the rings must have been formed about the planet, while subject to their common orbital motion, and under the full free influence of all the acting powers." Such is the complexity of the system of Saturn:—the immense globe of the planet, itself a thousand times larger than the earth, in rapid motion, and surrounded with a compound ring of such immense dimensions, as we have mentioned above, and with eight moons, all in rapid motion around the body of the planet, and with the planet in space around the sun,—as well as the doctrine of gravitation, as all forbid the idea of these bodies having been formed or their

motions adjusted to each other when in rapid motion in space, and subject to all the acting forces.

But the main question which will suggest itself in the case before us is: If the cosmos as to the phenomena of forms, changes, &c., have not, at sometime, existed mainly as it does now, how has it come to exist thus? One of the first ideas that strike the mind when investigating this subject is that of the gradual condensation of matter from all sides towards a common centre. This probably led some to suppose that the earth and all the celestial bodies are the results of a gradual condensation or closing in of the matter of which they are composed towards their several common centres. But such a thought or theory is inconsistent with the general theory of gravitation, with the regularity and precision of the motions of the spheres, as well as with the character and constitution of the earth as to solid, liquid, and gaseous. All things on the earth's surface, and for a certain distance in a perpendicular direction from its surface, tend or are attracted toward its centre. So, doubtless, it is with all the celestial spheres. If an earthly body, solid or liquid, is rarified sufficiently by heat, it ascends from its surface, but becoming condensed in the atmosphere it returns to the earth's surface again. You can reduce water to the form of a gas, as steam, but it becomes vapor in the atmosphere, accumulates into clouds and descends to the earth again in the form of water or rain. Also, if any earthly substance, mineral or metal be reduced to a gas, every particle of it will soon find its way to the earth again in some form or in different forms, for the atmosphere is so constituted as to be sufficient in itself to answer the purpose which it is adapted to fulfil. Water is also so constituted as to be a stable element, sufficient in itself to fulfil the purpose for which it is adapted; there is always exactly the same quantity of it in the earth, and, belonging to the earth, in the atmosphere in the form of vapor. The solid parts of the earth also are so constituted as to be a stable element, sufficient in itself to fulfil the purpose for which it is adapted; for, as we have stated, if an earthly substance or mineral be reduced to an aeriform state every particle of it will find its way to the earth again: the atmosphere does not want it, having enough of its own, and whilst it remains there it is a foreign in the midst of a native element. Also, if any part of the dry land by earthquakes, the action of the waves on coasts, or any occurrence in nature, be submerged, an equal extent will be freed from the dominion of the waters in some other place; and men bringing their land plants and animals with them, they will all be propagated upon this new land to supply the place of those vegetables and animals which were lost by submergence. There is no sufficient

reason to believe that more than small portions of land are lost at any time by the water, or that more than small portions are set free when compared with the whole extent of the dry land.

The solids of the earth, the waters, and the atmosphere always retain their natural or normal bulk, if not expanded by the admission to them of an excess of heat, or contracted by the abstraction of some of the heat that naturally belongs to them. A certain quantity of heat, as we have before said, belongs to all bodies, and so long as they possess just that amount and no more, or no less, they are said to be in their natural or normal state. And the doctrines of natural science prove, as clearly as anything can be proved, the stability of fluids if allowed to remain in their natural state. It is proved by hydrostatics and pneumatics that fluids press equally in all directions.* For example: fill a cubic measure full of water or atmospheric air, the lid being put on air-tight, the pressure upwards against the lid of the vessel will be the same as that downwards against its bottom, and the pressure against its sides will be equal to the upward or downward pressure. This is seen more clearly in the case of a globe-shaped vessel filled with water or air; the pressure outwards upon every point of the inside of the sphere will be equal; and the fluid is said to be in stable equilibrium. Let it be remembered that the fluid in both of these cases needs to be in its natural state; for if either water or atmospheric air be possessed of more than its natural amount of heat its tendency is to ascend, and, therefore, the pressure upwards against the lid of the vessel would be greater than that downward or in any other direction. Heated water is seen to ascend in the shape of steam, and the air, heated in the fire place, makes its way up the chimney, carrying with it the unconsumed particles of charcoal, in which condition it is called smoke.

The fact of air and water or any other body, expanded by heat, ascending perpendicularly rather than going in any other direction from the earth's surface, needs explanation. Thus it will be remembered that the earth is round like a ball, and is continually revolving round an imaginary line, passing from its north to its south poles or points, and called the earth's axis. It revolves round its circumference in the space of about twenty-four hours, producing in that length of time the succession of day and night. When it is noon-day with us in the northern hemisphere, it is midnight with those

* Such is the general statement in Hydrostatics and Pneumatics, but it is necessary to modify it thus: the lateral pressure varies according to the perpendicular height, that is to say, it increases with the square of the depth; and in this respect it is governed by precisely the same law that governs the velocity of "falling bodies;" see farther on page 43. See also Joyce's Scientific dialogues under Hydrostatics as to this limitation.

residing in the southern hemisphere, and during the interval of twelve hours, between twelve o'clock night and twelve o'clock noon, the earth has travelled round half her circumference, or over 12,000 miles; and during the interval of twelve hours more, between twelve o'clock, noon, and twelve o'clock, night, the earth has travelled over 12,000 miles more, or the other half of her circumference; for the whole circumference of the earth is nearly 25,000 miles. It will be readily understood, therefore, that the inhabitants of the southern hemisphere have the soles of their feet directly opposite to those of ours, and their heads pointing in contrary directions to our heads. Hence in the day-time, when we consider ourselves looking up into the heavens and contemplating the sun, they must necessarily be looking downwards, or in the contrary direction, when viewing the stars; and in the night-time, when we consider ourselves looking up into the heavens and contemplating the moon, the stars and the milky way, it being their day-time, they must be looking downwards, or in the contrary direction, when viewing the sun. And, conversely, during their day-time, which is our night, when they imagine themselves looking up toward the sun and the shining heavens, we must necessarily be looking downwards, or in the contrary direction, while gazing on the moon, the stars and the milky way; and during their night-time, which is our day, when they imagine themselves looking up toward the heavens at the stars, the moon and the milky way, we must necessarily be looking downwards, or in a contrary direction, while contemplating the sun in his brightness passing the meridian. Hence, as in natural science it is proved that equal and opposite forces, acting on the same plane, produce a negative result, so it is here as evidently proved that there is *neither up nor down* as regards the universe, or, speaking otherwise, as regards infinite, spiritual or material existence.* This subject may be more clearly illustrated by the use of an artificial globe, such as are used in schools. Thus, the earth being round like a ball, when a body is expanded by heat into a gas at any point of its surface, it will take a direction perpendicular to the place where it begins to be expanded in separating itself from the earth's surface. Hence, if the whole earth underwent a gradual expansion at the same time, the expanding matter going in directions perpendicular to every point of the earth's surface, we may conceive that the earth, provided it became

* In this connection it is fitting to remark that there are alike apparent contradictions with respect to the motions of the earth. Thus the earth moves round its axis in a contrary direction to that in which it moves round the sun. And in its motion toward the constellation, Hercules, in company with the sun and the other members of his system, it moves in a direction different from either of these. So that the threefold contradiction, apparently, at least, nullifies the real motion. The fact, however, of the antipodes having identical impressions as to the Cosmos leaves no doubt in the reflecting mind that the perceptive faculty, the real self, soul or mind, is spirit infinite and absolute, the perceived ideas or sensations being finite, relative and phenomenal.

reduced into fluid, all of the same density, would be expanded into an immense gaseous globe, perhaps fifty or one hundred thousand times its present dimensions, though still retaining its globular form. This we have shown before to be theoretically probable, though it is not practically so, for as long as the material elements, solid, liquid, and gaseous, of which our earth and atmosphere are composed have neither more nor less heat than what naturally belongs to them, they will remain in their natural state.

“It was, doubtless, the almost uniform globular figure of the heavenly bodies, which suggested to the mind the idea of their origin by the gradual condensation of their matters towards their respective centers. To this spherical form of the heavenly bodies no exception occurs to our senses but Saturn’s compound ring, with, perhaps that of Neptune, among the many thousands of those bodies, which the telescope has brought to our view. And in relation to their origin it is asked: “if (their actual form being considered) the gradual condensation theory be not really the most probable? for, if their origin were otherwise, it is queried, might they not be expected to present many different polyhedral forms besides the globular?” The evidences that the earth is a globe are complete and irresistible; and every one who has the use of his eyes knows by observation that the sun and moon are round. The telescope enables us to contemplate the planets of the solar system from a nearer standpoint than that at which we survey the moon without its aid. All these planets are of globular shape, each performing its motions in space as the earth is. Telescopes of high magnifying power, such as that of Herschell and Earl Rosse, also virtually transport us to the regions of the fixed stars, regions so immensely distant that any conceivable agent, travelling at the rate of twelve millions of miles a minute, would take scores, yea hundreds, and from some of them, thousands of years to reach our earth. Although the distance of those stars are so immensely great that none of them have yet been closely contemplated, still there is evidence, judging from the *cones* of light which they send forth, to show them to be of globular figure.

The great nebular systems, so many of which have been brought into view by the telescope, are found when closely scrutinized by telescopes of great space-penetrating power, to consist of systems of stars, each star of which it is reasonably conjectured is the centre sun of a planetary system, and each star and planet of which is most probably of the globular form. Over 3600 of these systems of nebulae have been discovered in the northern and southern hemispheres. The nebulae which were known to astronomers before the great telescopes were invented had given rise to various theories, and, among

them, this, to which the assent of many minds was given, that the formation of the celestial spheres took place from the gradual condensation of celestial vapor, such as these nebulae appeared to them to be. Sir Wm. Herschell's great telescope first dispelled this idea by showing that many of the nebulae, so regarded as vapor, were really clusters of stars; but at the same time by its space-penetrating power it reveals new nebulae before unknown and beyond its resolving power. The construction of Earl Rosse's great telescope next contributed a new and vastly increased resolving power, and again showed the nebulae unresolved before consisted of star-clusters only still more remote, but at the same time it added to our knowledge the existence of other nebulae before unknown, and, in turn, beyond its power of resolution. "Thus," says Humboldt, "by increasing optical power, resolution of old and discovery of new would follow each other in endless succession; so that it may be fairly asked whether we can with probability assume both such a state of the universe, and such a degree of improvement in optical instruments, that in the whole firmament there shall not remain one unresolved nebulae." When the phenomena which gave rise to the theory of gradual condensation had vanished, one would think that the false impression to which the theory gave rise should vanish also. It is not, however, necessary for any one to conclude that all the bodies existing in space, as our earth is, are of globular form, for, although all those we can see with our eyes and all the telescope has brought within our view are of that form, yet the universe being infinite, there may still remain bodies existing in it of great diversity of form.

Also, the laws of gravitation, by which all things on or near the earth's surface are drawn towards its centre with a force proportional to their weight, are further proof of the earth's permanence. Although the laws of gravitation act universally, yet that which we have to speak of concerning them here relates to the earth and its neighbor globes of the solar system. We have before endeavored to illustrate that the earth is round like a ball; and as we know by observation and experience that all things on the side of the earth on which we are tend towards its centre, even so all things on the side of the earth opposite to us are attracted toward the same centre but in a contrary direction. Every point on the earth's surface has a point situated directly opposite to it in another hemisphere of the earth: thus, we and all around us are attracted towards the earth's centre, while those in Australia, directly opposite to us, are attracted toward the same centre in a contrary direction. Those also in Central Asia are attracted toward the earth's centre in a direction contrary to that in which the people of Brazil are attracted towards the same

centre; and those living in Northern Africa and Europe are attracted in a direction contrary to that in which the New Zealanders are attracted. Thus we see all bodies, wherever they are situated on the earth's surface, are attracted towards its centre. The force of this attraction is found to be the same at all points on the earth's surface, with the exception of an exceedingly slight variation at the North and South Poles. This being so there are equal and opposite forces in operation at all points on the earth's surface, which produces a negation; for equal and opposite forces acting on the same plane, produce a negative result. Now, as every point on the earth's surface has a corresponding point directly opposite to it on the other side of the earth, and as there are two forces connecting these two points respectively with the earth's centre which are equal and acting directly opposite to each other, these forces may be conceived to meet on opposite sides of a plane, situated at right angles to their direction, and to produce a negative result, that is, no result beyond nullifying each other.* These two forces represent any two equal and opposite forces, or any number of equal and opposite forces acting towards the earth's centre, and from this the conclusion *appears* evident that the earth as a whole, or any analogous co-existing body in space, has, of itself, no weight. It may, therefore, truly be said that there are no forces of attraction connecting the surface of the earth with its centre, except that by which lighter bodies have to yield to heavier ones. This, however, is a definite force, well-known, and acting uniformly and universally. The earth's elements, and consequently itself, are so constituted as to be in equilibrium; and the reason why bodies in its atmosphere tend towards its surface, and those on its surface towards its centre is because their specific gravity is greater than the medium in which they are; and because the interior and centre of the earth are made up of weightier materials than its exterior parts. Put a piece of iron into water, and it sinks to the bottom; put a piece of wood in, and it floats on the top; because the weight, that is, the specific gravity of the iron, is greater than its own bulk of water and that of the wood lighter. Elevate a solid body of any kind in the air, and having nothing to support it, it falls to the earth, because its weight is greater than that of its own bulk of air. In one sense, therefore, gravity means the same as weight, and the word *gravitas* is

* This conclusion, you see, corresponds to the conclusions we have come to as to the motions and shows that, at least apparently, gravitation means nothing beyond what we here explain as to the invariable descent or approach of lighter bodies towards heavier ones, or of the rarer to the more dense, or of the less attractive to the more attractive, as the loadstone. That Gravitation, as Light, Heat, Magnetism, Motion, &c., is a modification of the one general substance or an effect of the one great agency, is here quite apparent. We give a more simple illustration of it farther on under the head of the "Attraction of Gravitation."

the Latin for the English word *weight*. It may seem strange to some that the earth, being round like a ball, should have the faculty of drawing bodies towards itself at every point of its surface; for, if a solid body be elevated in the air at a point of the earth directly opposite to that which we occupy, the body falls to its surface, as with us; and if iron or wood be there thrown into the water, the one will sink and the other float, as with us. Now it is known beyond all doubt, that all bodies possess the power of attraction in proportion to the quantity of matter they contain. Some bodies, as the loadstone, possess it even in a greater degree. It is plain, therefore, that the earth being so much larger than any body on or near its surface, possesses the power of attracting them to itself at every point on its surface. This power, however, is not limited in its action by the earth's surface, but extends into the atmosphere and far into space. It is the earth's attraction which retains the moon in its orbit round the earth; and it is the sun's attraction which retains the earth and moon in their orbit round the sun; and, conversely, it is the attraction of the earth and moon and all the planets which retains the sun in his position and orbit in space. The attraction, therefore, is mutual between all bodies in space, and in the main acts in proportion to their several weights. Bodies, however small, at or near the earth's surface, attract the earth in proportion to their weight; but the earth being so much weightier than any of these, their attraction is as nothing compared with the earth's, and, therefore, all these small forces yield to the attraction of the earth. The earth, also, being nearly fifty times larger than the moon, exerts on the latter a proportional attraction, and thus retains it in its orbit round the earth, and prevents it from flying off into space in a tangential direction, which that body, as all other globes in space, has a tendency to do, if not counteracted by the superior weight of other bodies. And the sun being over 1,300,000 times larger than the earth, and considerably larger than all the known planets of his system taken together, exerts a balancing power over all these bodies. It is plain, therefore, that all these bodies are in equilibrium, and that the principle of attraction may be resolved into that of the maintenance of equilibrium, and of the stability of order. The universe, though it may be considered as one great whole, is constituted of different parts, and these parts of different elements, all of the same general substance, but in different degrees of density and rarity. The earth, though composed of three elements, solid, liquid, and aeriform, each of which fills its own place and performs its own functions in the earth's economy, may be called a unit; and each of these constituent parts may be called unit in relation to the constitution of the earth; but yet the earth is

only a member of universal existence, filling its own place, and performing its own functions, as the other members are.

We have mentioned before with what regularity the earth and the heavenly bodies move. This regularity and precision is not greater than that which governs bodies falling towards the earth's surface. Small bodies will not fall to the earth unless they be within the sphere of the earth's attraction. By this we mean that there are parts of space in which the earth's attraction is nothing. The sun, moon, and each of the planets has a sphere of attraction of its own. But then, there are spaces intermediate of these bodies, which do not come within their spheres of attraction in any sensible degree. There, as we have before remarked, the ether is in equilibrium. Not that the attraction of each of these bodies is not exerted on each of the others, but that their contrary attractions, counteracting each other, produce equilibrium in certain parts of the space intermediate of these bodies.

The attraction of gravity, and the dispersion of light and heat, are analogous in their operation. The force of all these decreases with the square of the distance from the centre of action. Suppose you are reading at a certain distance from a candle, and that you receive a certain quantity of light on your book, if you remove to double that distance from the candle you will enjoy four times less light than you had before; here, then, though you have but doubled your distance, you have diminished your light four-fold, because four is the square of two. If, instead of doubling your distance from the candle, you remove to three, four, five, or six times the distance from it, you will then receive at these different distances, nine, sixteen, twenty-five, or thirty-six times less light than you did at first, for these, respectively, are the squares of the numbers three, four, five, six. The same is applicable to the heat imparted by a fire, at a distance of two yards, from which a person will enjoy four times less heat than one who sits at one yard from it, and at three yards distance nine times less heat, and so on decreasing with the square of the distance from the fire. And if a body is removed to double the distance from the centre of gravity, the attraction exerted on it is one-fourth; if to three times the distance, it is one-ninth; if to four times the distance, one-sixteenth, and so on decreasing as the squares of the distances increase.

All bodies have their centres of gravity or points about which all their parts are balanced. The earth's centre of gravity is its centre. The *differences of the power* of the earth's attraction are not discernible at short distances from its surface, owing to the distance of the latter from the centre of gravity. But it is determined that, could we ascend 4000 miles from its surface, or double the distance of the

surface from the centre, we should there find the attractive force to be one-fourth of what it is here; or, for example, that a body, which at the earth's surface weighs one pound, would, at 4000 miles above the earth, weigh but a quarter of a pound. By the most accurate observations the moon is found to be obedient to the same laws of attraction as other heavy bodies are. Its mean distance is clearly ascertained to be about 240,000 miles, or equal to about sixty semi-diameters of the earth, and, of course, the earth's attraction on the moon ought to diminish in the proportion of the square of this distance, that is, it ought to be sixty times sixty, or 3600 times less at the moon than it is at the earth's surface. This is found to be the case by the *measure of the deviation* of its course from a right line. Bodies near the earth's surface, when left free to descend, fall at the rate of sixteen feet in the first second of time; but as the attraction of gravity is continually acting, so the body continues to fall with an increasing, or, as it is usually called, an accelerating velocity. It has been determined, by the most accurate experiments, that a body falling from a considerable height, by the force of gravity, falls sixteen feet in the first second; three times sixteen feet in the next, five times sixteen feet in the third; seven times sixteen feet in the fourth, and so on, constantly increasing according to the odd numbers, one, three, five, seven, nine, etc. By reason of the centrifugal force, that is, the force which impels the earth in its orbit, the distance fallen in the first second varies a little in different latitudes.

The following rule holds in all cases as to falling bodies: that the spaces they describe when falling freely from a state of rest increase as the squares of the times increase. Or, the following formulæ with respect to falling bodies will convey a clearer idea of the uniformity with which this law acts:

Seconds.	Space passed over in a second.	Velocity at end of second.	Total space passed over to end of second.
1	1	2	1 = 1 ²
2	3	4	4 = 2 ²
3	5	6	9 = 3 ²
4	7	8	16 = 4 ²
5	9	10	25 = 5 ²
6	11	12	36 = 6 ²
7	13	14	49 = 7 ²

If, after the demonstration of the uniformity of the action of gravity, any one should be puzzled to understand how it is that while the earth is continually rolling round like a ball, it retains all things in connection with it to its surface, they should remember that we constantly meet with illustrations of this force. A can, filled with water may be swung round the head without a drop being spilt. When

the can is at its highest point, and therefore has its mouth downwards, the water is attracted towards the earth; but this attraction is more than overcome by the centrifugal force, or the force of the hand by which the can is swung, and hence it remains in the can as if it were solid. It does not lose a particle of its water. Some persons are worried because they say they cannot understand this with regard to the earth, but the same persons hardly ever consider how it is that flies and other insects walk upon a perpendicular pane of glass or upon the ceiling over their heads. Does this not seem as inexplicable as the other?

But something has, at least, been adduced to show the probability of the permanency of the cosmos, constituted in general as to phenomena of form, motion, elements, &c., as it is now. Nothing can be brought forward to prove the contrary of that probability; and if any one attempted to prove such contrary, it would be well for him to prove how it came into existence, how it attained its present general constitution as to elements, forms, motions, &c.; how it is maintained in this constitution, where, in short, it came from, and as we may suppose such a one would hold the doctrine of its final destruction, where it is going to, and when?

We have shown heretofore that matter and spirit are the same thing * in different states as to density and rarity; that the most solid substances can be reduced to an aeriform state, and it is of the same essence in the gaseous form as it is in the solid. In the one case it is condensed, in the other expanded; in the one case it is the solid, tangible substance, in the other the intangible, invisible gas. Spirit, from the Latin word *spirare*, to breathe, from which our words inspire, expire, etc., are derived, means that which we breathe, or breath. The Greek word for the same thing is *πνεύμα*, wind, or breath, from which our technical word, pneumatics, is derived, meaning the science which treats of wind or air. Also, the Hebrew word, translated into our language, spirit, means air or wind; as for instance in the second verse of the first chapter of Genesis, it says, the Spirit of God moved upon the face of the waters, which equals, the wind of God moved upon the face of the waters. The difference between spirit and matter, then, is only one of degree of density and rarity of substance; it is the same substance in two different states; in the one state in a form to be breathed, in the other in a form too dense to be breathed. We do not mean to say that air derived from the reduction of any and every solid substance to ■

(*) Mind, as it relates to man, is properly called a development from matter or from spirit; but mind is really infinite and universal as is deity. The soul as applied to man means the living, conscious, rational human being, and in a wider sense the principle of life in man.

gaseous form would be fit to be breathed by human beings and all the animal creation; we mean only that it would be air or wind (for wind is air in a state of motion) just as much air as is the atmosphere which surrounds us. We do not mean to say that the solid parts of the earth, or even water, are intended to be reduced to air and breathed; indeed their very constitution, and the purposes they fulfil in the production and support of animals and vegetables, indicate different. The atmosphere is that one constituent element of our terrestrial system, which is intended to be breathed. Each of the three constituent elements of our system has its own purpose to fulfil, and yet they are all three mutually helpful to each other. The atmosphere and water may be called the servants of the solid earth. The earth needs air and water as well as the solar light in order to the production and support of vegetables and animals. The earth also supplies oxygen to the atmosphere, and absorbs the impurities with which that element becomes impregnated. This operation is performed by the leaves or lungs of vegetables, which absorb the carbonic acid (*) from the air, retain its carbon to increase the solid tissue of their plants, and expire or reject its oxygen, which is the vital principle of the air we breathe. The atmosphere, as a sponge, sucks up the water from the surface of the ocean, of lakes and rivers, and lets it down upon the thirsty earth again in the form of rain. This process of imbibing water by the atmosphere is called evaporation. These three elements are, as we have before remarked, modifications of the same general substance, each so constituted that nothing can be added to or taken from it; but they are all three mutually dependent on each other, as the parts of the human or other animal body are dependent on each other. When water is evaporated from the surface of the ocean, of lakes, and of rivers, it is not lost—not a particle of it goes beyond the sphere of the earth's attraction; but having descended to the earth again as rain, snow, etc., it in due time finds its way into the rivers and thence to the ocean. When a tree decays, part of it becomes water, part carbonic acid, and part humus or clay. When any vegetable or animal body goes to decay, its component parts return eventually to their original elements, earth, water, and air. These three elements in the constitution of the terrestrial system form an individual or unit, just as the parts and members of the human body form an individual or unit.

Matter is defined in general terms to be everything which is an object of our senses, and includes the ideas of extension, solidity, inactivity, and mobility. The theory with respect to the constitution of matter hitherto is: that all matter is made up of infinitely small

(*) Carbonic acid is composed of Carbon and Oxygen.

particles, called atoms, that is, parts so minute as to be incapable of further division; and that these atoms or ultimate particles are unchangeable and indestructible, unless the power which gave them existence so effects it. The most minute particles, which even the microscope can only just discern, may contain millions of these atoms, so that they must be infinitely beyond the reach of the recognition of our senses. A molecule (a little mass) which may be called the secondary atom, is the smallest particle capable of existing by itself. This, though it may contain millions of atoms and be undiscernible by the naked eye, is considered the ultimate particle of a compound body. For a long time the theory supposed these molecules to be round, solid particles, but the expansion and contraction of bodies under the influence of light, heat, and electricity had never been satisfactorily accounted for on this hypothesis, nor how solid bodies become liquid, and solid and liquid bodies become gasiform. The theory, therefore, has for some time supposed that the molecules of matter are not solid, but are filled with electricity, as the soap bubble is with air, and are, like it, capable of great elastic expansion and contraction, and that they are only round like the soap bubble when taken singly, but are polyhedral or manysided over all their surfaces of contact, when like the soap bubbles in connection with each other, or in clusters. This theory shows how electricity, which undoubtedly pervades all bodies, may be contained within the molecules: and also how electricity, which is undoubtedly capable of expanding all bodies, can expand them; and further, how molecules, which, from extreme contraction are hard, and solid, and opaque, may, by extreme expansion and rarefaction, become fluid, gaseous, diaphanous, and transparent. It also satisfies the chemical requirement of definite atoms for proportional admixtures of different elements and their concurrent expansion and contraction within definite limits in the compounds they form.

But let us see from the following illustrations what these molecules are which are conceived to be filled with electricity, by this also seeing the extent to which matter is capable of being subdivided.

One hundred cubic inches of a solution of common salt will be rendered milky, by adding to it a cube of silver, each side of which measures the $\frac{1}{4000}$ of an inch, dissolved in nitric acid. The atoms of silver have found their way into every particle of water, and there with the salt formed the white chloride of silver, which rendered the solution milky; that is, the small cube of silver has divided itself into at least one hundred trillions of parts,* a number which the seconds pendulum of a clock would beat in 3,168,969 years;

* $\frac{100000000000000}{31,556,928}$, that is, we multiply each of the small cubes by 1000, and divide by the number of seconds in a year.

and even yet we are not sure that we have approached the measure of an atom of silver, we have only reached the limits of our power of subdivision. A single grain of gold can be spread into a leaf containing 50 square inches, and this leaf may be readily divided into 500,000 parts, each of which is visible to the naked eye; and, by the help of a microscope which magnifies the area of a surface 100 times, the 100th part of each of these becomes visible; that is the 50 millionth part of a grain of gold will be visible, or a single grain of that metal may be divided into fifty millions of visible parts. But the gold which covers the silver wire used in making gold lace is spread over a much larger surface, yet it preserves, if examined by a microscope, a uniform appearance. It has been calculated that a single grain of gold under these circumstances would cover a surface of nearly thirty square yards.

If a bar of silver be gilded and then drawn out into a wire, the thread may be so fine that the gold covering one foot weighs less than the $\frac{1}{6000}$ of a grain; an inch of this wire will contain the $\frac{1}{72000}$ th of a grain; this may be divided into 100 parts, each visible to the eye, and being covered by the $\frac{1}{7200000}$ or the one 7 million 2 hundred thousandth part of a grain of gold. Under a microscope, magnifying 500 times, each of these pieces may be subdivided by the eye into 500 parts, the gold retaining its original appearance, and showing no signs of dividing into its separate atoms; and yet the particle visible to the eye, that which covers the upper part of the wire, is $\frac{1}{7200000000}$ or the one seven thousand two hundred millionth of a grain.

If a pound of silver wire which contains 5760 grains, and a single grain of gold be melted together, the gold will be equally diffused through the whole silver, insomuch that if one grain of the mass be dissolved in aqua fortis, the gold will fall to the bottom. By this experiment it is evident that a grain of gold may be divided into 5761 visible parts, for only the 5761st part of the gold is contained in a single grain of the mass.

The diffusibility of parts of natural bodies is still more surprising. Odoriferous bodies, such as camphor, musk, and asafoetida are perceived to have a wonderful subtilty of parts; for though they are perpetually filling a considerable space with odoriferous particles, yet these bodies are found not to lose any sensible part of their weight in a great length of time.

Again, it is said by those who have examined the subject with the best glasses, and whose accuracy of observation is not questioned, that there are more animals in the milt of a single codfish, than there are men on the whole earth, and that a single grain of sand is larger

than four millions of those animals. Now if it be admitted that these little animals are possessed of organized parts, such as a heart, stomach, muscles, veins, arteries, etc., and that they are possessed of a complete system of circulating fluids, similar to what is found in larger animals, we evidently approach the idea of the infinite reducibility of matter. It has indeed been calculated that a particle of the blood of one of these animalculæ is as much smaller than a globe one-tenth of an inch in diameter as that globe is smaller than the whole earth.

Captain Scoresby, in his account of the Greenland Seas, states that, in July, 1818, his vessel sailed for several leagues in water of a very uncommon appearance. The surface was variegated with large patches of a yellowish-green color. It was found to be produced by animalculæ, and microscopes were applied to examine them. In a single drop of the water examined by a power of 28,224 (magnified superficies) there were fifty in number on an average in each square of the micrometer glass of $\frac{1}{340}$ th of an inch in diameter; and as the drop occupied a circle on a plate of glass containing 529 of these squares there must have been in this single drop of water taken at random out of the sea, and in a place not the most discolored, about 26,450 animalculæ. How inconceivably minute must the vessels, organs, and fluids of these animals be! A whale requires a sea to sport in; a hundred and fifty millions of these would have ample scope for their evolutions in a cup of water! We might adduce many more instances of a like kind, but these we doubt not will be sufficient to illustrate into what exceedingly minute parts matter is capable of being subdivided; parts so infinitely minute that they are evidently a rare fluid or gas, reducible doubtless to as rare a gas as the air we breath or to the much more subtile ether.

We have, therefore, theoretically demonstrated that all existing things are reducible to a substance of the same density throughout, in which case there should be no objects to be conceived; nothing defined by limitations; no circumstances, no place or space, only an infinite essentiality; such as we may be allowed to think may possibly have been before the primal creation?

Such an infinite essentiality is to us nothing, *i. e.* no thing. But the creation of one object therein creates at the same time both place and space. The creation of two objects, — such as globes, — endowed with motions relative to each other, such as we conceive our globes now have, creates time. But, although we have theoretically reduced all to nothing still we do not consider it necessary to deprive the scientific world of its atomic theory, since it is found expedient for scientific purposes. But, for our own part, we consider chemical affinity all that is necessary.

Affinity in the language of chemistry is that force in virtue of

which two or more substances combine to form a compound body. This body exhibits properties different from those of the combining elements, and is called a chemical compound. Some substances display a greater affinity for each other than others do. For example, if we take a piece of chalk, and put it in a glass of water, in due time it will become softened, and if the water be stirred, the chalk will render it milky, but no change has taken place, for if it be let stand the chalk will sink to the bottom, or, if the water be evaporated, the chalk may be recovered unaltered. But had a little nitric acid been added to the water, bubbles of gas would have arisen to the surface, and the water would have become clear. The chalk was composed of lime and carbonic acid. The nitric acid having been added a combination of it takes place with the chalk, by which carbonic acid gas is set free, and escapes in bubbles from the surface of the water. If now the water be evaporated, chalk will no longer be found, but a transparent crystallized substance, called the nitrate of lime, very different from the lime or the nitric acid of which it is composed. Here then is an illustration of chemical affinity, and of chemical combination. Chemical action always evolves heat. The action which took place when the nitric acid came into contact with the chalk was analogous to that which takes place when a stick of wood is thrown on the fire, in which case heat and flame result, and the component parts of the wood enter into new combinations. This phenomenon of chemical affinity very plainly depends upon the principle of electrical attraction. We have before explained that electricity, light, and heat, are the same substance under different modes of action and manifestation; or rather that electricity might be regarded as the element of which light and heat are peculiar manifestations. This element pervades all bodies, which only require to be properly acted upon in order that it be made apparent in heat, or light, or both. Before the invention of lucifer matches the blacksmith, in order to kindle his fire, battered a nail on his anvil until it became red hot. Also, the savage who has no access to the means employed by civilized people for making a fire, educes that element by rubbing together two sticks of wood. Even water is pervaded by the active principle of combustion, and if thrown on a blazing fire in insufficient quantity tends not to quench but to strengthen the flame. All bodies in their natural condition are supposed to contain a certain amount of this electric fluid, and if they possess no more and no less than this natural amount they tend to remain in the same electric state. But if a body contains more than its natural amount it is said to be positively electrified, if less it is said to be negatively electrified. When a positively electrified body is brought near or

in contact with a negatively electrified one, attraction takes place between them, and the former discharges its surplus fluid into the latter to make up for its deficiency. Thus, thunder is caused by a positively electrified cloud coming near a negatively electrified one, which it attracts, and discharging into it its surplus electricity; and the lightning is merely a manifestation of the electric fluid itself. But what causes the noise, it will be asked, which scares the children? The noise is caused by the electric discharge rushing through the air, and in its course displacing its own volume of the latter, thus causing a vacuum which the air from all sides rushes in to fill up. This combination of causes produces the thunder, but principally the air in rushing in to fill up the vacuum. When two bodies having more than their natural share of electricity come near or in contact with each other they tend to repel each other. This principle of electrical attraction and repulsion satisfactorily explains why some substances have a strong inclination to combine with each other chemically, while others exhibit little or no desire to do so. Now, in the example before us, the nitric acid and the chalk attract each other, one of the two containing a less amount of electricity than the other; and thus, combining with each other, heat is evolved, and consequently gas is set free, and a chemical compound results. But the whole process of chemical combination is explainable on the principles of equilibrial diffusion of electricity, and the change and recombination of matter.

We have already endeavored to illustrate how that not only life but intelligence is inherent in all matter. Now that we have resolved all matter into spirit it will not be difficult to understand that proposition. The mind readily conceives of the principle of life as existing in all spirit, though it may not conceive of it so readily as existing in all matter. This, we think, arises in the main from the mind being habituated to think in a certain way concerning matter and spirit, and from a certain meaning which has been given to the word spirit in the ancient world, and especially in the Christian world, a meaning not original or literal, but collateral; not essential, but only attributive. For instance, the word spirit is commonly used to express the disposition, inclinations, state of heart or temper of a human being, although it is not often thought that the air the individual breathes is the literal spirit, or that the human being himself is a real, though not in his present state a literal, spirit. Also, the Deity is especially spoken of as a spirit, invisible and everywhere existing, which is very true, for an infinite being cannot be conceived by the mind, much less seen; and if a being be infinite he must be everywhere present; confessed as a being he cannot be nowhere

Lockyer's theoretical discovery of the reducability of all the elementary substances to a single one I had as clear in my mind as the above demonstration makes it, and published, long before I heard of him.

But as we know that we exist and as we see the works of the Creator in nature all round us we know that he exists and exists everywhere. But the Deity, as everywhere existing, speaking both from a physical and moral point of view, must include bad as well as good, false as well as true God. What we have said hitherto with respect to the Creator we mean also of the Deity, for the Creator and the Deity we understand as synonymous terms for the same Being. The Deity, then, though unseen, must comprehend in Himself all that is seen to exist, and to be perpetuated in existence, in the two opposite aspects of evil and good in which it is seen by us, for the physical as well as the moral world presents existence in these two contrary aspects.

Some terrestrial climatal conditions and peculiarities noticed, as well as illustrations from the noxious and innoxious portions of the animal and vegetable kingdoms.

In the physical world we have the frigidly cold climates of the North and South polar regions,—the regions of eternal snow and ice, in which animal life cannot exist, and where if human beings try to live for a short season they must suffer the effects of intense, biting cold, and be every moment in danger of being frozen to death. We have also the parching torrid zone for twenty degrees immediately north and south of the equator, where men and animals suffer almost as much from the effects of the burning heat of a verticle sun, as in the polar regions from the effects of the intolerable cold. In contrast with these we have the mild climates of the temperate zones, where men enjoy the most delightful and refreshing breezes; the most beautiful scenery, and magnificent and sublime prospects of creation; the most lavish abundance of the good and useful productions of the earth, both animal and vegetable; where nature with benignant smile and outstretched hand seems to anticipate the various wants of man, and offers him in luxuriant abundance even more than his heart desires.

Certain parts of the earth are subject periodically to violent storms and tempests, hurricanes and tornadoes, which often render men lifeless or homeless, and cause a great deal of terror, inconvenience, and damage to the inhabitants of the districts where they prevail. The hurricane and tornado are destructive winds that prevail upon the American Continent, and in the West India Islands, causing terror and often death both to men and the inferior animals. Then there are the poisonous winds, the terrible harmattan, and sirocco, and samiel, and simoom, which prevail upon the continent of Africa, and

in the south-western countries of Asia, causing the inhabitants of these countries to quake and hide their heads, as well as often causing much destruction to life and property. In contrast with these we have the mild and genial breezes of our temperate climates, which are favorable to vegetation and to animal health; and, also, the trade-winds and monsoons which enable our seafaring men to navigate every sea and ocean, and to waft the products of the earth and of the arts from land to land.

In the animal kingdom we can contemplate the character and disposition displayed by the wild carnivorous animals of the land, the lion, the tiger, the hyena, the wolf, the bear, the jackal, the wild-cat, etc.; and the monstrous carnivora of the ocean, as the shark, the whale, the porpoise, and others innumerable, about which we know nothing. And among the reptile tribes we can contemplate the boa constrictor, the rattle-snake, the adder, the alligator, the crocodile, the anaconda, etc.; and also among ravenous birds, the eagle, the ostrich, the vulture, the hawk, the raven, etc. And on the other hand we can contemplate the character and disposition of the gentle and useful domesticated animals, the sheep, the cow, the horse, the goat, the deer, the camel, the dromedary, the tamed elephant, the ass, the dog, the cat, the pig; also, among birds, the pigeon, the hen, the goose, the duck, the guinea-hen, etc.

In the vegetable kingdom we are presented with two varieties, noxious and innoxious plants. Poisonous plants are numerous—indeed, they are to be found in most of the species, but some species contain many more than others. The order *Ranunculaceæ*, for example, of flowering plants, are almost all poisonous, and in some cases the poison is so virulent, that death speedily results from swallowing a very minute portion of the fruit. More than one poisonous principle abounds in this tribe; but of these the alkali termed by chemists *aconitum* is the most violent. It is a white substance something like flour to look at, and so frightfully poisonous that the twentieth part of a grain or even less is a fatal dose. Of all the various species of *aconitum*, that termed *aconitum ferox* is the most dangerous. This plant grows in the Himalaya Mountains, and was on one occasion made use of by the natives to rid themselves of their subjugators, the English. A few leaves of this plant having been thrown into a well so poisoned the water, that men or beasts drinking it were almost infallibly killed. Also, the Poppy tribe, especially cultivated in India, is that which supplies the opium which is doing so much to poison the Chinese and the Hindoos. Plants belonging to the order *Ranunculaceæ* are supplied with a watery, acrid, poisonous juice; but in plants of the Poppy tribe the juice is milky, from which milky

juice the luxury, opium, is expressed. Also, the great natural order *Umbellifera*, or umbrella, bearing plants, are of a dangerously doubtful character. Their chemical characteristics may be said to depend on the presence either of an odorous, volatile oil, or of a poisonous matter. Everybody knows how agreeably odorous is caraway seed, and most people are aware of the poisonous nature of the hemlock, and of the noxious character of the fools' parsley. The advantage when one is in an unknown country of being a practical botanist, so as to be able to refer a plant to a harmless or noxious kind, is considerable. It is related that when, during Anson's voyage, his crews disembarked in unknown places, the surgeon, fearful of poison, would not allow them to partake of any vegetables, except grasses, notwithstanding the scurvy was making great ravages among them.

The greater number if not all the members of the order *Cucurbitacæ*, or cucumber tribe, contain a bitter poisonous principle, presenting many degrees of intensity. In the colocynth it attains its maximum. In the ordinary cucumber the poisonous bitter principle is usually but little developed, never to the extent of being dangerous, although frequently enough to be disagreeable. In the melon, sugar is the principle secretion, nevertheless, the bitter principle so prevalent in the family is present in a small degree; it exists in the outside rind of the fruit, and to a still greater degree in the roots, which are violently emetic. Bryonia, another species, is still more violent in its poisonous action than the colocynth. Also, nearly all, if not all members of the order *Solanaceæ*, or night-shade tribe, contain a poison of a narcotic kind. To this order belong the common night-shade, henbane, tobacco, stramonium, and the mandrake plant. It is a highly dangerous family of plants, although one that ministers to our sustenance in the potato. Even this is not entirely free from poison; the fruits are notoriously poisonous, and even the juice of raw potatoes is highly injurious. The nutritive properties of the potato arise from the starch and gluten which it contains being mingled with so little of the poisonous principle, that the latter is destroyed by the cooking process to which the potatoes are subjected before eaten. The egg-plant and tomato belongs to this family; the former is occasionally eaten, the latter frequently and almost universally by the Spaniards, and now by the Americans. We may here remark that the vegetable substance, starch, is largely diffused throughout many poisonous plants, yet when separated from them it is invariably harmless. Of this we have a remarkable example in tapioca, which is nothing else than the baked starch extracted from the trunk of a tree, the *jatropha manihot*. The juice of this tree is so poisonous that they poison arrows with it; nevertheless, tapioca is

a delicate article of food. The common deadly night-shade, atropa belladonna, grows in shady places, and is an elegant though dangerous-looking plant. We may here remark that, as a general rule, most plants having dark-green foliage, and dark-colored flowers are poisonous. The belladonna bears a cherry-like fruit, which is sometimes incautiously eaten by children, and too often with a fatal result. In 1793 some orphans brought up in the *Hospice de la Piété* at Paris were employed in weeding a botanical garden. They happened to be attracted by the tempting-looking fruit of the belladonna plant, of which they ate a considerable quantity. Fourteen of these unfortunate children died in consequence only a few hours afterwards. This lamentable catastrophe justifies the generic name atropa, from Atropos, one of the fates, who was supposed to cut the thread of life. The specific name, belladonna, signifies beautiful lady, and is dependent on the circumstance that the Italian ladies used the distilled water of this plant as a cosmetic. They foolishly imagine that it improves their complexions. The mandrake is a species very nearly allied to the belladonna. It grows in the South of Europe, and in dark places. This plant, known and celebrated from times of great antiquity, was employed by the sorcerers of ancient days to produce narcotism, and disordered vision. Its roots are large, often two-pronged, whence its fancied resemblance to the limbs of a man. This plant has, from very early periods of history, been regarded with much superstitious dread, which has probably arisen partly from its poisonous properties, and partly from its large and irregularly shaped roots, which at times approximate to the uncouth form of a man. Shakespeare writes: "And shrieks the mandrakes torn out of the earth, that living mortals hearing them run mad." The notion that prevailed in days gone by regarding the sounds of complaint uttered by the mandrake when being rooted up appears to have been widely entertained by the ignorant. Misfortune of the direst kind was believed to be the portion of any one bold or rash enough to engage in disturbing the mandrake in his earthbed. An old English proverb says: "He who gathereth the mandrake shall die; blood for blood is his destinie." It is supposed that the mandrakes mentioned in some parts of the Old Testament were not the same as the plant known to us by this name, but that under this term reference is had to the fragrant but insipid fruit of the *Cucumis Dudaim*, a plant which is cultivated in the gardens of the East for the odor it exhales. The mandrake is also confounded with the sleep-apple, a mossy excrescence on the wild rose, which when laid under the pillow was supposed not to allow any one to wake until it was taken away. This property of stupefying doubtless arose from its narcotic properties.

Henbane is a European plant belonging to this genus under consideration. It is a biennial plant, and grows amidst the ruins of buildings, in the neighborhood of habitations. Its stem is studded with a cotton-like substance, and it constantly exhales a repulsive odor. Its corolla is palish yellow, veined with purple. It owes its peculiar properties to the presence of a peculiar alkali. Its action is far less powerful than that of belladonna; nevertheless it may cause death if eaten. A German physician relates that, on a certain occasion, the Benedictine monks of the convent of Rhinon were presented with a salad in which the root of chicory, as was thought, had been placed. Instead, however, of being of chicory the root was of henbane. After the repast the monks went to bed. Symptoms of poisoning soon commenced; the monks were all stupefied. The time for matins or morning prayers arrived, and one monk was so fast asleep that his fellows supposed him to be dying, and under this impression administered to him extreme unction. The other monks went to chapel, but they had much better have stayed away; some of them could not even open their eyes, much less read. The vision of others was so disordered that they thought insects were crawling on their books, and employed themselves in blowing and brushing the intruders off. Others instead of praying uttered nonsense. In the end all the monks got well, even the one supposed to be dead; but one poor individual, a tailor, could not thread his needle for a long time afterwards, so disordered was the state of his vision. Instead of one needle the tailor saw three, and as he could not tell the real needle from its ghostlike duplicates, there was slight chance of his threading it. This anecdote illustrates better than any mere description the physiological action of henbane.

The stramonium is another plant of the Night-shade order. It was unknown to the ancient Greeks and Romans, but is now common in Europe, having been brought from Central Asia in the Middle Ages by the wandering gipsies. Its active principle is called *daturine*, which exists in the leaves and in the seeds. This principle is a potent narcotic alkaloid, resembling in its quality and the effects it produces the alkaloids yielded by the henbane and belladonna. It is a deadly poison, and among the most striking of its properties may be named the effect it produces on the pupil of the eye, namely, that of causing it to dilate strongly. Nevertheless the stramonium, or the thorn-apple as it is sometimes called, like many other poisonous plants, has its beneficial uses. In Cochin China a decoction made of its leaves is considered an effectual remedy for hydrophobia, the terrible malady resulting from the bite of a mad dog; but this by some is considered very doubtful. In small quantities *daturine* is very

useful as a pain-soother or anodyne, and as an antispasmodic. Persons suffering from asthma have found relief from smoking the dried leaves of the plant, or inhaling an infusion made by pouring boiling water on the seeds or leaves. Great care, however, should be used lest the patient take an overdose. Tobacco is another plant belonging to this natural order, and the use or abuse of which is too well known to require comment here.

The order *Euphorbiaceæ*, to which the castor-oil plant belongs, is mainly made up of very dangerous plants. The greater number of its species contain a milky, acrid, and poisonous juice, which often holds dissolved, in addition to other principles, a peculiar elastic substance, and occasionally a coloring matter. The species *Euphorbiæ*, the type of this natural order, presents an aspect of great variety. The manchineel is a large tree of intertropical America, celebrated for its peculiarly poisonous qualities. If accounts are to be trusted it is certain death for an individual to sleep under the shade of one of this species; and even rain which touches the skin after having fallen upon the leaves of this tree raises a blister. The manchineel tree also bears tempting looking fruit, from which an agreeable odor is exhaled, but even a small portion if eaten produces certain death.

The order called *Loganiaceæ* is also largely represented by poisonous plants. The sub-family strychnos contains the most remarkable species of this natural order. The greater number possess in their bark and seeds two alkaline principles, termed respectively strychnine and brucine. The action of these on the animal organism is extremely violent. The *Strychnos-tiente* is a climbing plant of the Javanese forest, with the juice of which the natives poison their arrows. It is the famous Upas and is often confounded with another Javanese vegetable poison, obtained from the *Antiaris Toxicaria*, a tree belonging to the natural family Artocarpeæ. The ourari, or vourali, is also a poison furnished by another member of the same natural family, the strychnos toxifera, a native of Guiana. The Indians who dwell on the banks of the Orinoco, the Ipura and the Rio Negro, employ this substance as a poison for their arrows. The nux vomica tree, or koochla tree of India, is perhaps the most valuable of this tribe, furnishing an alkaloid, strychnine, very poisonous, but of great use in medicine.

The natural order Apocynaceæ, which name Greek scholars will recognize, and is significant of the dog-killing power of certain of its species, is also a dangerous tribe. The plants belonging to this order are usually trees or shrubs, seldom herbs, and for the most part containing a milky juice. This natural order is rather frequent in tropical climates, but the number of species is very inconsiderable in

our latitudes. The milky, acrid and bitter juice which flows, from many of these plants imparts to the family an emetic and purgative tendency which in some species is deleterious. The bark of many of the dog-banes contains a bitter astringent principle; in other species a tinctorial matter predominates. The seeds of many genera are poisonous. Many species of the genus *cerbera*, as well Asiatic as American, possess narcotic acrid seeds, sometimes poisonous, but useful as a remedy for the bites of serpents. The *cerbera ahouai* secretes an exceedingly poisonous juice, which is employed in Brazil for the purpose of stupefying fish. The poisonous *tanghin* is a native of Madagascar, about thirty feet in height, yielding a dropaceous fruit which contains an oily seed, and is employed by the natives judiciously in the trials by poison. The accuser makes his complaint to the judge, who refers it to an official denominated the *ampanan-ghin*, and whose office is the double one of priest and executioner. If sufficient presumptive evidence of crime is forthcoming, the *tanghin* is administered and the guilt or innocence of the accused is judged by the result. If he recover from the effects of the poison he is declared innocent. If he die he is considered guilty and his goods are forfeited. Even the natural order of endogenous plants to which the grasses and cereals belong is not without its poisonous species. The *darnel* grass is strongly poisonous owing to the presence of the chemical principle *loine*. *Festuca quadredentata*, a species which grows abundantly in Peru, is mortal to cattle which graze upon it. Another species *balmogrostis*, is juiceless, and, when swallowed by animals, injures their throats, rather on account of the flinty matter with which it is profusely coated than because of any poisonous principle it contains. The orders here mentioned contain each many genera, species, and varieties, and what we have adduced as to poisonous vegetables gives only a very general idea of their number and varieties in the vegetable kingdom.

But this abstract from the vegetable kingdom concerning noxious plants, together with what we have shown concerning the climatic conditions and changes of the earth, and the character of the savage carnivorous portion of the animal kingdom, should be fully sufficient to show the fallacy that underlies the effort of Dr. Dick and others to demonstrate that the earth and all things were created for the especial use and benefit of mankind.

Having taken a glance at the noxious portion of the vegetable world, it will be proper, for the purpose of contrast, to give a passing notice to the innoxious portion of it. With this part of the vegetable kingdom people are better acquainted than they are with the other. In this part are contained the plants which furnish the food for

the human race and for the inferior orders of animals. It will not be necessary, therefore, to give any extended description of it; for what everybody knows to some extent, or may know extensively by a little observation, they need not be told about in detail in such a treatise as this.

All seed-bearing plants are classed by botanists under the two general natural divisions of *exogenous* plants, or those which grow or increase by external depositions of their substance; and *endogenous* plants, or those which grow or increase by internal depositions of their substance. Of the former class the oak, the elm, and most large trees are specimens; of the latter the palm tree, the bamboo, the sugar cane and a stalk of wheat, rye or oats may serve as specimens. Most of the vegetables which minister to our sustenance belong to the endogenous division. Thus, all the species of grasses are endogenous. The smaller species clothe our fields with verdure and afford nourishment to cattle; the larger species furnish us with bread and sugar, for the reader may remember that not only the species commonly called grass which the cattle graze upon, but wheat, barley, rice, maize, oats, rye, and even the sugar-cane, the bamboo, and the palm-tree, are, botanically considered, grasses. Is it not wonderful that mankind subsists chiefly on grass! Linnæus, the celebrated Swedish naturalist, has remarked that the cow eats 276 species of plants, and rejects 218; the goat eats 449, and rejects 126; the sheep eats 347, and rejects 141; the horse eats 262, and rejects 212; and the hog, more nice in its taste than any of the rest, eats but 72, and rejects all the rest. Whether these animals reject certain plants on account of certain poisonous principles which they possess, or simply because of a peculiar nicety of taste in themselves, we shall leave to be determined by others.

Grasses are not excluded from any quarter of the globe, but the number of individuals, though not of species, is greatest in the northern temperate regions; also, they have become so transported from one region of the earth to another, that it seems now quite impossible to determine with certainty the native regions of many species. Oats and rye are mostly cultivated towards the north; barley and wheat in more temperate regions; maize is a staple product of America, and rice of Asia. The seed or rather the fruit of these afford sustenance to the greater portions of the human race. The analogy of the chemical composition of grasses as well as their external characters indicates their mutual affinities pointing out the whole family as essentially nutritive vegetables. The grain or seed contains starch or gluten in abundance, mixed with a certain quantity of sugar, the amount of which increases toward the period of germination; they

also contain a little fixed oil and various saline matters. Innocuity and the presence of nutritive principles are the grand characteristics of grasses physiologically considered. The sugar-cane is supposed to be a native of South-eastern Asia. It was unknown to the ancient Greeks and Romans, as also was sugar. From South-eastern Asia the cane was introduced into Arabia, and it thence was introduced into Egypt, Asia-Minor, Sicily, Italy, and Spain. From the latter country it was transported to St. Domingo and the mainland of America. It is cultivated to a considerably large extent and furnishes much to the benefit of the human race. The corn-bearing grasses are appropriately denominated cereals, or plants of Ceres, the goddess of corn, among the ancient Greeks and Romans. Amongst these wheat takes the first rank. It is more nutritive than any of the others, and is adapted to climes and tracts of greater diversity of character. Rice may be correctly described as a tropical water-grass, the conditions necessary to its growth being a hot atmosphere, and a swampy soil. These conditions exist in Asia, where rice is cultivated to a large extent, and in the southern temperate and tropical climates of America. The conditions necessary to the growth of rice are unfavorable to the health of man. The palm tree is a plant which furnishes a number of useful products, such as oil, wine, dates, cocoa, nuts, hemp, astringent matter, sugar, and spirit; also an excellent fruit is furnished by the banana a species of palm tree. The maple tree affords a large amount of sugar to the people of the United States and Canada, who prepare and use that article to a great extent. The various species of apple tree furnish a fruit which is used in a variety of forms for human food. Also, the various species of peaches, plums, cherries, gooseberries, prunes, apricots, pineapples, strawberries, raspberries, currants, grapes, etc., as well as the various species of wild fruits, too numerous indeed to mention here, and of a wholesome nature, all afford their stores of nutritive food for the sustenance of man. Also, if we enumerate the roots, bulbs, and tubers, which are cultivated by the farmer and gardener, such as parsnips, carrots, beets, turnips, potatoes, etc., we shall find that a large store is furnished from this source, also, for the maintenance of man and beast.

If we enumerate the forest trees we have the various species of the oak, fir, pine, cedar, ash, larch, walnut, hickory, elm, birch, hemlock, etc., which all contribute to supply man's wants, if not in the way of food, yet in other important ways.

Then there are the various species of flowering plants which adorn the fields and gardens, which are not of a poisonous nature, and which add such varied and diversified beauties to the prospect

before us. During the summer season, when all nature is clothed with verdure, when the trees and plants are blooming with flowers and blossoms of varied hue, when the birds are warbling their melodious notes, when the various species of corn are growing and ripening in the fields, when the various kinds of domestic animals are seen to gambol and frolic about the lawns, and nature seems to smile benignantly in bringing forth an abundant supply for the wants of all her animate offspring, then does not our earth seem a present heaven!

*Illustrations from the character and practices of the Races of Mankind :
first, from the Savage and Semi-civilized races.*

If we take a survey of the various tribes of mankind we find a great variety of character and disposition displayed. The two extremes of evil and good are here comprised. Man is undoubtedly the most savage and brutal of all terrestrial animals, but is susceptible of becoming the most gentle, kind and intelligent. In dealing with this part of our subject we shall first take a glance at the state of the uncivilized races of mankind, and at those nations by whom terrible scenes of barbarity are wont to be enacted and terrible deeds of atrocity are wont to be perpetrated, and then we shall take a glance at the races called civilized, both of the past and present.

Contemplate with us the character and disposition of savage tribes, of the New Zealanders, the South Sea Islanders, the Australians; the Bushmen, Caffres and numerous other African tribes; of the numerous nations of Indians of North and South America, of the ancient Mexicans, and of the Asiatic tribes of Huns, Tartars, etc., and what a horrid and disgusting picture of human cruelty, brutality, barbarism, and savage malignancy will be presented to the mind. The most prominent feature which appears in the character of savage nations is their disposition for war, and to inflict revenge for real or supposed injuries. The dismal effects of the principle of hatred directed toward human beings, the disposition to be engaged in war continually, and the savage ferocity of the human mind when unrestrained by moral and prudential considerations, are nowhere more strikingly displayed than in the islands scattered through the wide expanse of the Pacific and Indian oceans. Of the truth of those positions we have but too many melancholy examples, in the reports of missionaries and in the journals which have been published by navigators, from which we select a few. The first instance we shall adduce relates chiefly to the inhabitants of New Zealand. Captain Cook remarks in relation to those islanders: "Their public conten-

tions are frequent, or rather perpetual; for it appears, from their number of weapons and dexterity in using them, that war is their principal profession. The war-dance consists of a great variety of violent motions and hideous contortions of the limbs, during which the countenance also performs a part; the tongue is frequently thrust out to an incredible length, and the eyelid so forcibly drawn up, that the white appears both above and below as well as on each side of the iris, so as to form a circle around it; nor is anything neglected so as to render the human shape frightful and deformed. To such as have not been accustomed to such a practice they appear more like demons than men, and would almost chill the boldest with fear; at the same time they brandish their spears, shake their darts, and cleave the air with their patoopatoos. To this succeeds a circumstance almost foretold in their fierce demeanor, horrid and disgraceful to human nature, which is cutting to pieces, even before being perfectly dead, the bodies of their enemies, and after dressing them on a fire, devouring the flesh, not only without reluctance, but with peculiar satisfaction." One cannot well conceive a more striking idea of the workings of pure malevolence, and of the rage and fury of infernal fiends, than the picture here presented of those savage islanders. These people, so far as European power and civilization has not reached them, live under perpetual apprehension of being destroyed by each other; there being few of these tribes who have not, as they believe, received wrong from some other tribe, which they are continually on the watch to avenge, and the desire of a good meal is no small incitement. "Many years will sometimes elapse before a favorable opportunity happens, but the son never loses sight of an injury that has been done his father. Their method of executing their horrible designs is by stealing upon the adverse party in the night, and if they find them unguarded, which is very seldom the case, they kill every one indiscriminately, not even sparing the women and children. When the massacre is completed they either feast and gorge themselves on the spot, or carry off as many of the dead bodies as they can, and devour them at home with acts of brutality too shocking to be described. If they are discovered before they execute their bloody purpose, they generally steal off again, and are sometimes pursued and attacked by the other party in their turn. To give quarter or to take prisoners make no part of their military law, so that the vanquished can save their lives only by flight. This perpetual state of war, and destructive method of conducting it, operates so strongly in producing habits of circumspection, that one hardly ever finds a New Zealander off his guard, either by night or by day." The implacable hatred which these savages entertain for

each other is illustrated in the following short narrative, also by Captain Cook. "Among our occasional visitors was a chief called Kahoorā, who, as I was informed, headed the party that cut off Captain Furneaux's people, and himself killed Mr. Row, the officer who commanded. To judge of the character of Kahoorā from what I heard from many of his countrymen he seemed to be more feared than beloved among them. Not satisfied with telling me that he was a very bad man, some of them even importuned me to kill him, and I believe they were not a little surprised that I did not listen to them, for, according to their ideas of equity, this ought to have been done. But if I had followed the advice of all our pretended friends, I might have extinguished the whole race; for the people of each village or hamlet by turns applied to me to destroy the others. One would have almost thought it impossible that so striking a proof of the divided state in which these people lived could have been assigned."

Similar dispositions are displayed by the inhabitants of almost all the other islands of the South Seas. The influence of Christianity does not as yet prevail very extensively among them. The following description is given by M. de la Perouse of the inhabitants of Maroua Orjolava, and the other islands in the Navigator's Archipelago:—"Their native ferocity of countenance always expresses either surprise or anger. The least dispute among them is followed by blows of sticks, clubs, or paddles, and often, without doubt, costs the combatant's their lives." With regard to the women he remarks:—"The gross effrontery of their conduct, the indecency of their motions, and the disgusting offers which they make of their favors rendered them fit mothers and wives for the ferocious beings that surrounded us.

The natives of New Caledonia are a race of a similar description. Captain Cook describes them as apparently a good-natured people, but subsequent navigators have found them to be the very reverse of what he described them,—as ferocious in the extreme, addicted to cannibalism, and to every barbarity shocking to human nature. The French navigator, the Admiral D'Entrecasteaux, in his intercourse with these people received undoubted proof of their savage disposition, and of their being accustomed to eat human flesh. Speaking of one of the natives who had visited his ship, and had described the various practices connected with cannibalism, he says: "It is difficult to depict the ferocious avidity with which he expressed to us that the flesh of their unfortunate victims was devoured by them after they had broiled it on the coals. This cannibal also let us know that the flesh of the arms and legs was cut into slices, and that

they considered the most muscular parts a very agreeable dish. It was then easy for us to explain why they frequently felt our arms and legs, manifesting a violent longing; they then uttered a faint whistling which they produced by closing their teeth, and applying to them the tip of the tongue; afterwards opening their mouth they smack their lips several times in succession. The characters of the islanders now described may be considered as common to the inhabitants of the New Hebrides, the Friendly Islands, the Marquesas, the Sandwich Islands, New Guinea, New Britain, the Ladrões, and almost all the islands that are scattered through the vast expanse of the Pacific Ocean. Mr. Williams, a missionary to the Fijian cannibals, remarks among other things: "Some captives who had been stunned by the fearful blows of their heavy war clubs were cast into hot ovens, and when the fierce heat brought them back to consciousness and urged them to fearful struggles to escape, the loud laughter of the spectators bore witness to their joy at the scene." Captain Cook, in describing the natives of New Zealand, again remarks: "The inhabitants of the other islands of the South Seas have not even the ideas of indecency with respect to any object or to any action." Of the natives of Otaheite he declares: "They are all arrant thieves, and can pick pockets with the dexterity of the most expert London blackguard." When describing the societies distinguished by the name of Arreoy he declares as a characteristic of the female part of the community: "If any of the women happen to be with child, which in this manner of life happens less frequently than in ordinary cases, the poor infant is smothered the moment it is born, that it may be no incumbrance to the father, nor interrupt the mother in the pleasures of her diabolical prostitution." Another circumstance mentioned by the same navigator exhibits their former moral character in a still more shocking point of view. On the approach of war with any of the neighboring islands, or on other important occasions, human sacrifices were a universal practice. "When I described," says Captain Cook, "the Native at Tongataboo, I mentioned that on the approaching sequel of that festival we had been told that ten men were to be sacrificed. This may give us an idea of the extent of the religious massacres on that island. And, though we should suppose that never more than one person is sacrificed on any single occasion at Otaheite, it is more than probable that these occasions happened so frequently as to make a shocking waste of the human race, for I counted no less than forty-nine skulls of former victims lying before the Morai, where we saw one more added to the number. And, as none of these skulls had as yet suffered any considerable change from the weather, it may be inferred

that no great length of time had elapsed since this considerable number of unhappy wretches had been offered on the altar of blood." He likewise informs us that human sacrifices were more frequent in the Sandwich than in the other islands. "These horrid rites," says he, "are not only had recourse to upon the commencement of war and preceding great battles, and other signal enterprises, but the death of any considerable chief calls for the sacrifice of one or more tow-tows, that is, vulgar or low persons, according to his rank, and we were told that ten men were destined to suffer on the death of Terreeoboo, one of their great chiefs.

With respect to the North American Indians (who have now almost disappeared from the Eastern States and Canada) it is the uniform description given of them by all who have travelled or lived among them in their wild state that, if we except hunting, war is the only employment of the men, and every other concern is left to the women. Their most common motive for entering into war is either to revenge themselves for the death of some friend, or to acquire prisoners who may assist them in their hunting and whom they adopt into their society. In these wars they are savage and cruel to an incredible degree. They enter unawares the villages of their foes, and while the flower of the nation are engaged in hunting, massacre all the children, women, and helpless old men, or make prisoners of as many as they can manage. But, when the enemy is apprised of their design, and is coming on in arms against them they throw themselves flat on the ground among the withered herbs and leaves which their faces are painted to resemble. They then allow a part to pass unmolested, when all at once, with a tremendous shout, rising up from the ambush, they pour a storm of musket-balls on their foes. If the force on each side continues nearly equal, the fierce spirits of these savages, inflamed by the loss of friends, can no longer be restrained. They abandon their distant war, they rush upon one another with clubs and tomahawks in their hands, magnifying their own courage and insulting their enemies. A cruel combat ensues; death appears in a thousand hideous forms, which would congeal the blood of civilized people to behold, but which increases the fury of these savages. They trample, they insult over the dead bodies, tearing the scalp from the head, wallowing in their blood like wild beasts, and sometimes devouring their flesh. The flame of war rages on until it meets with no resistance, then the prisoners are secured, whose fate is a thousand times more dreadful than theirs who have died in the field. The conquerors set up a hideous howling to lament the friends they have lost. They approach to their own village, the women with frightful shrieks come

out to mourn their dead brothers, or their husbands. An orator proclaims aloud a circumstantial account of every particular of the expedition, and, as he mentions the names of those who have fallen, the shrieks of the women are redoubled. The last ceremony is the proclamation of victory; each individual then forgets his private misfortune, and joins in the triumph of his nation; all tears are wiped from their eyes; by a transition unaccountable to us, they pass in a moment from the bitterness of sorrow to an extravagance of joy. As they feel nothing but revenge for the enemies of their nation, their prisoners are treated with extreme cruelty. The punishments inflicted on such prisoners as are doomed to death are too shocking and horrible to be exhibited in detail; one plucks out the nails of the prisoner by the roots; another takes a finger into his mouth and tears off the flesh with his teeth; a third thrusts the finger mangled as it is into the bowl of a pipe, made red hot, and smokes it as if it were tobacco; they then pound his toes and fingers to pieces between two stones; they apply red hot iron to his mangled body; and thus they continue for several hours, and sometimes for a whole day, until they penetrate to the vital parts and completely exhaust the spring of life. Even the women, forgetting the human as well as the female nature, and transformed into something worse than the reputed Furies, frequently outdo the men in this scene of horror, while the principal persons of the tribe sit round the stake to which the prisoner is fixed, smoking and looking on without betraying the least emotion. And, what is quite as remarkable, the prisoner himself endeavors to brave his torments with a stoical apathy; "I do not fear death" (he exclaims in the face of his tormentors), "nor any kind of tortures; those that fear them are cowards, they are less than women. May my enemies be confounded with despair and rage! Oh! that I could devour them and drink their blood to the last drop!" Such is a faint picture of the ferocious dispositions which, with a few modifications, have characterized the Indians of North and South America, and which we have reason to believe yet characterize those who are beyond the reach or influence of the white races. We ourself, have some experience of the character of the Indians who live in the neighborhood of the whites; for happening occasionally to be where they were, and observing their noisy conversation and their unruly gestures, we felt considerably alarmed for our own safety, and did not wish to be among them longer than our duties required.

If we cross the Atlantic and land on the shores of Africa we shall find the inhabitants of that continent exhibiting dispositions no less cruel and ferocious. Bosman relates the following instances of

cruelties practiced by the Adomese Negroes, inhabiting the banks of the Praa or Chamah River: "Anqua, the king, having in an engagement taken five of his principal Antese enemies prisoners wounded them all over: after which with a more than brutal fury, he satiated, though not tired himself, by sucking their blood at the gaping wounds; but bearing a more than ordinary grudge against one of them he caused him to be laid bound at his feet, and his body to be pierced with hot irons, gathering the blood that issued from him in a vessel, one half of which he drank, and offered up the rest to his god. On another occasion he put to death one of his wives and a slave, drinking their blood also, as was his usual practice with his enemies."* Dispositions and practices quite as abominable are exhibited in the kingdom of Dahomey near the gulf of Guinea. An immolation of human victims for the purpose of watering the graves of the king's ancestors, and of supplying them with servants of various descriptions in the other world, takes place every year, at a grand festival which is held generally in April or May. The victims are generally prisoners of war reserved for the purpose, but should there be a lack of these, the number, between sixty and seventy, is made up from the most convenient of his own subjects. The immolation is not confined to this particular period: for at any time, should it be necessary to send an account to his forefathers of any remarkable event, the king despatches a courier to the shades, by delivering a message to whomsoever may happen to be near him, and then ordering his head to be chopped off immediately. It is considered an honor when His Majesty personally condescends to become the executioner in these cases, an office in which the king prides himself in being expert. The governor was present on one occasion, when a poor fellow, whose fear of death outweighing the sense of the honor conferred upon him, on being desired to carry some message to his father declared on his knees that he was unacquainted with the way, on which the tyrant vociferated, "I'll show you the way," and with one blow made the head fly many yards from his body, highly indignant that there should have been the least expression of reluctance.† On the thatched roofs of the guard-houses which surround the palace of this tyrant are ranged, on wooden stakes, numbers of human skulls; the top of the wall which encloses an area before it is stuck full of human jaw-bones, and the path leading to the door is paved with skulls.

In the Kingdom of Ashantee similar practices uniformly prevail. "When the king of this country," says Dupuis, "was about to open the campaign in Gaman, he collected together his priests to invoke

* Dupuis Journal in Ashantee. Bowditch's Journey to Ashantee.

† MacLeod's Voyage to Africa. Dalzell's Hist. of an Expedition to Dahomey.

the Royal Fetische (idol) and perform the necessary orgies to ensure success. These ministers of superstition sacrificed thirty-two male, and eighteen female victims, as an expiatory offering to the gods; but the answers from the priests being deemed by the council as still devoid of inspiration, the king was induced to make a *custom* at the sepulchres of his ancestors, where many hundreds bled. This, it is affirmed, propitiated the wrath of the adverse god." The same king when he returned from the campaign, having discovered a conspiracy, decreed that seventeen of his wives along with his own sister should be strangled and beheaded. His sister's paramour, and all those of the same party, were doomed to the most cruel deaths at the grave of the king's mother. While these butcheries were transacting the king prepared to enter the palace; and in the act of crossing the threshold of the outer gate was met by several of his wives whose anxiety to embrace their sovereign lord impelled them thus to overstep the boundary of female decorum in Ashantee; for it happened that the king was accompanied by a number of his captains, who accordingly were compelled to cover their faces with both their hands, and fly from the spot. This is said to have enraged the monarch, though his resentment proceeded no further than words, and he returned the embraces of his wives; but another cause of anger soon after occurred, and he was inflamed to the highest pitch of indignation, and in a paroxysm of anger, caused these unhappy beings to be cut into pieces before his face, giving orders at the same time to cast the fragments into the forest to be devoured by birds and beasts of prey, nor did the atonement rest here; for six more unhappy females were impeached of inconstancy, and they also expiated their faults with their lives. Like another Ulysses, His Majesty then devoted himself to the purification of his palace, when to sum up the whole horror of these bloody deeds, two thousand wretches selected from the Gaman prisoners of war, were slaughtered over the royal deathstool in honor of the shades of departed kings and heroes. We are not to imagine that such fiendish and malignant dispositions are confined to kings and the ruling order of society. Whenever such ferocious passions are displayed among barbarous chieftains, they pervade to a greater or less extent the great mass of the people, and almost every one in proportion to the power with which he is invested perpetrates similar atrocities. The following instance, selected from Major Gray's "Travels in Africa, in 1824," will corroborate this position, and also show for how many acts of cruelty and injustice the abettors of the infamous traffic in slaves are accountable. The Kaartan force which the Major accompanied had made 107 prisoners, chiefly women and children, in a predatory excursion into Bondoo, for the purpose

of obtaining a supply of slaves. The following is an account of the manner in which they were dragged along: "The men were tied in pairs by the necks, their hands secured behind their backs; the women by the necks only, but their hands were not left free from any sense of feeling for them, but in order to enable them to balance their immense loads of corn or rice, which they were obliged to carry on their heads, and their children on their backs." "I had an opportunity," says Major Gray, "of witnessing, during this short march, the new-made slaves, and the sufferings to which they are subjected in their first state of bondage. They were hurried along, tied, at a pace little short of running, to enable them to keep up with the horsemen, who drove them on as Smithfield drovers do fatigued bullocks. Many of the women were old, and by no means able to endure such treatment. One in particular would not have failed to excite the tenderest feelings in the breast of any one, save a savage African. She was at least sixty years old, in the most miserable state of emaciation and debility, nearly doubled together, and with difficulty dragging her tottering limbs along. To crown the heart-rending picture, she was naked save from her waist to about half way to the knees. All this did not prevent her inhuman captor from making her carry a heavy load of water, while with a rope about her neck he drove her before his horse; and whenever she showed the least inclination to stop he beat her in the most unmerciful manner with a stick." The inhabitants of all the interior of Africa, and round its northern, eastern and western coasts, display in almost every tribe the most inhuman and depraved dispositions. The Algerines are characterized as the most cruel and dangerous pirates, base, perfidious and rapacious, to the last degree. No oaths or ties, human or divine, will avail to bind them, when their interest interferes. Whatever respect they pretend to pay to their prophet Mahomet, gold is the only idol which they worship. The emperors of Morocco are notorious as a set of rapacious and blood-thirsty tyrants, who have lived in a state of habitual warfare with Christian nations, and in the perpetration of deeds of injustice and cruelty. The Gallas, on the borders of Abyssinia, are a barbarous and warlike nation. They are hardy and of a ferocious disposition, trained to the love of desperate achievements, taught to believe that conquest entitles them to the possession of whatever they desire, and to look upon death with the utmost contempt; and, therefore, in their wars they fight with the most determined resolution, and neither give nor expect any quarter. The inhabitants of Adel, too, are of a warlike disposition, and most frequently live in enmity with those around them. The Feloops are gloomy and unforgiving in their tempers, thirsting for vengeance,

even in the hour of dissolution, and leaving to their children to avenge their quarrels. The inhabitants of the grain coast, especially the Mulattoes, are said to be a most abandoned set of people. The men are drunkards, lewd, thievish and treacherous, and the women are the most abandoned prostitutes, sacrificing themselves at all times, and to all sorts of men, without the least degree of restraint.*

The natives of Ansico, which borders on Angola, live by plundering all who happen to fall in their way, some of whom they kill, and others they keep slaves. The Boshemen are land pirates, who live without laws and without discipline; who lurk in thickets to watch the passage of travellers and shoot them with poisoned arrows, in order to seize their cattle. "The natives of Congo," says M. de la Brosse, in his "Travels along the Coast of Angola," 1793, "are extremely treacherous and vindictive. They daily demanded of us some brandy for the use of the king and the chief men of the town. One day this request was denied, and we had soon reason to repent it; for all the English and French officers having gone to fish on a small lake near the sea-coast, they erected a tent for the purpose of dressing and eating the fish they had caught, when amusing themselves after the repast, seven or eight negroes, who were the chiefs of Loango, arrived in Sedans, and presented their hands according to the custom of the country. The negroes privately rubbed the hands of the officers with a subtle poison, which acts instantaneously, and accordingly five captains and three surgeons died on the spot." The Moors are characterized by Mungo Park as having cruelty and low cunning depicted on their countenances.

Their treachery and malevolence are displayed in their plundering excursions against the negro-villages. Without the smallest provocation, and sometimes under the fairest professions of friendship, they will seize upon the cattle of the negroes, and sometimes upon the people themselves. The Bedouins are plunderers of the cultivated lands and highway robbers; they watch every opportunity of taking vengeance on their enemies, and their animosities are transmitted as an inheritance from father to children. Even the Egyptians, who are farther advanced in civilization than the tribes to which we have alluded, are characterized by excessive pride, vindictive tempers, inordinate passions, and various species of moral turpitude. There is a trait in the character of the women of this nation, adverted to by Sonini in his "Travels in Egypt," which is particularly odious and horrible. On discovering any partiality in their husbands for other females, they are transported into a most unbounded and jealous fury. Such are their deceit and vindictiveness on these occa-

* Cook's Universal Geography. Goldberry's Voyage en Afrique. Durand's Voyage au Senegal.

sions, that they instil into the blood of their faithless or suspected husbands a slow and mortal poison. They meditate their revenge in silence, and they enjoy the diabolical satisfaction of taking off an unhappy being by a lingering death. It is said their own persons supply the horrid means of perpetrating their malicious designs on their husbands, and that they mix with their aliment a certain portion of an ingredient of a poisonous nature, which infallibly induces a slow languor and consumption, and in time brings the wretched victims to the grave.

The symptoms of the disease are dreadful. The body desiccates, the limbs become exceedingly weak, the gums rot, the teeth loosen, the hair falls off, and at length, having dragged out a miserable and tortured existence for a whole year or more, the unhappy being dies in the most excruciating torments.

If we pass from Africa to the regions of Asia we shall find its inhabitants of a similarly depraved character, and practicing similar principles in all the various ranks of its population. Here tyranny in its most degrading and cruel form reigns supreme and uncontrolled over a superstitious, a degraded, and an idolatrous race of mankind. The following, in relation to a petty tyrant of Persia, may serve as a specimen of Asiatic tyranny: "The governor, Zulfecca Khan, is pronounced to be a cruel and unprincipled tyrant; unfortunately for the people he has the ear of the sovereign, and they have no resource against his rapacity. He pays to the Crown 7000 tomauns* a year, but it is asserted that he collects from the district 100,000. His oppression was so grievous that the inhabitants, wearied out, went in a body to the king to complain; but His Majesty only referred them back to their tyrant, who, exasperated at their boldness, wreaked upon them a cruel vengeance. It is said he maimed and put to death a thousand of both sexes, cutting off the hands, putting out the eyes, and otherwise mutilating the men; and cutting off the noses, ears, and breasts of the women. The people, desponding and broken-hearted after this, paid in so far as they were able the rapacious demands of their oppressor, and the natural consequence, ruin and desolation has ensued." †

Sir John Chardin gives the following account of the inhabitants of Mingrelia, particularly the women: "The people are generally handsome, the men strong and well made, and the women very beautiful, but both sexes are very vicious and debauched. The women, though lively, civil, and affectionate, are very perfidious for there is no wickedness which they will not perpetrate, in order to procure,

* A tomaun equals about \$3.02.

† Frazer's Journey to Khorazan.

to preserve, or to get rid of their gallants. The men likewise possess many bad qualities. All of them are trained to robbery, which they study both as a business and as an amusement. With great satisfaction they relate the depredations they have committed, and from this polluted source they derive their greatest praise and honor. In Mingrelia falsehood, depredation, and theft are good actions, and whoredom, bigamy, and incest, are esteemed as virtuous habits. The men marry two or three wives at a time, and keep as many concubines as they choose. They not only make a common practice of selling their children either for gold or in exchange for wares and provisions, but even murder them or bury them alive, when they find it difficult to bring them up."

The Tartars, who occupy vast regions of the high table lands of Eastern Asia, are uniformly described by travellers as a rude, plundering and uncultivated race of men. There is something frightful, they say, in the countenances of the Calmuck Tartars. All of them are wandering vagabonds, and live in tents made of cloth and skins. They eat the flesh of horses, either raw or a little softened by putrefying under their saddles. No marks of religion, or of any decency in their manners, are to be found amongst most of these tribes. They are fierce, warlike, hardy, and brutally gross. They are all robbers, and the Tartars of Daghestan, who border on civilized nations, have a great trade in slaves, whom they carry off by force, and sell to the Persians and Turks.

The Arabians, like the Tartars, live in a state of wildness and lawless independency; their chiefs authorize rape, theft, and robbery. They hold virtue in no estimation, and glory in almost every species of vice. They roam about in the desert, and attack caravans and travellers, wherever they fall in with them, whom they frequently plunder of their property and murder.

The Chinese, though undoubtedly more civilized than most of the tribes already mentioned, and though they merit praise for their industry, perseverance and ingenuity, are as despicable in their moral characters, and as destitute of true benevolence, as almost any nation on the earth. Avarice is their leading passion, and in order to gratify it they practice every species of duplicity and fraud. They are not wont to be influenced by motives either of honesty or humanity; and they surpass every other nation in private cheating. Captain Cook observes that, the danger of being hanged for any crime being excepted, "there is nothing, however infamous, which the Chinese will refuse to do for gain." In this declaration he concurs with most writers on the Chinese, both ancient and modern.

The Burmans are a lively inquisitive race, irascible and impatient; while in peace, they give proof of a certain degree of gentleness and civilization; in war, they display the ferocity of savages.

The Malays, though inhabiting a country beautiful and delightful in the extreme, where refreshing gales and cooling streams assuage the heat, where the soil teems with delicious fruits, where the trees are clothed with a continual verdure, and the flowers breathe their fragrant odors, are a people remarkably ferocious in their manners. They go always armed, except the slaves, and would think it a disgrace to go abroad without their poniards.

The inland inhabitants of Malacca, called Monucaboes, are a barbarous people, delighting in doing continued mischief to their neighbors, on which account, it is said, no grain is grown in Malacca, but what is in the gardens enclosed with the thickest hedges, or deep ditches; for when the corn is grown on the open plain the Monucaboes never fail to set fire to it.

Chardin describes the Persians as warlike, vain, and ambitious of praise, exceedingly voluptuous, prodigal, luxurious and addicted to gallantry. Although this country is regarded by the Western nations as one of the most civilized in Asia, it is well known that the wars and the fiendish cruelties in which the despots of Persia have been engaged, have changed many of the provinces of that country into scenes of sterility and desolation; and much of the miseries of famine, which has recently been desolating that country, is owing to its misgovernment.

The Hindoos are effeminate, luxurious, and practiced in the arts of dissimulation. They can caress those whom they hate, and behave with the utmost affability and kindness to those whom they intend to deprive of existence by the most sanguinary means. Though they seldom scold or wrangle, they often stab each other insidiously, and without any public quarrel gratify a private revenge. The destruction of infants, the immolation of widows, the drowning of aged parents, which prevail among them, and the cruel and idolatrous rites which distinguish their religious services, are too well known to require description.

The Turks, though grave, sedate, and rather hypochondriac, yet when agitated by passion are furious, raging, and ungovernable, dissimulative, jealous, suspicious and vindictive. They are superstitious and obstinately tenacious in religious matters, and, until of late, did not ordinarily exercise benevolence or even humanity towards those whose religion differed from theirs. Interest appears their supreme good, and, when that comes in competition, all ties of religion, consanguinity and friendship are, with the generality of them, speedily

dissolved. They have deprived of their liberty, and to a great extent of their wealth, those who have been subjected to their iron sceptre, and have plunged them into the depths of moral and mental debasement. Their devastations and cruelties, and the deeds of injustice and horror which they have committed, are detailed upon the pages of history, and they are scarcely surpassed by the atrocities of the most savage hordes of mankind.

Such is a partial review of the moral state of the savage and semi-civilized races of mankind, and shall we find a review of the nations called civilized to present a favorable contrast to it? Shall we find that the general moral goodness of the nations called civilized compares favorably with the radical and general moral badness of the nations we have passed in review? Each intelligent person can answer this for himself. What one nation can be pointed to as a good moral example for all other nations to follow? It will be much easier to find an individual man whose moral example would be worthy of being imitated by all the inhabitants of his own nation and all mankind than it would be to find a nation whose moral character, as a nation, would be worthy of being imitated by all other nations.

Idea of the Moral World.

In the moral world, as well as in the physical, there are degrees of approximation to perfection. The physical universe, of course, always exists perfectly constituted, but within the range of our observation we find changes continually taking place in nature. There is first the blade, then the ear, after that the full corn in the ear. The moral world exists in relation to man, and so changes to suit his changeable nature that we hear of moral badness as well as moral goodness. And then there are degrees of approximation from a very bad to a very good moral character. The word moral, derived from the Latin word *mos*, *mores*, meaning customs, manners, usages, etc., will clearly show the distinction between the physical and moral world, and that the moral world has special reference to rational beings. People's morals are their manners, customs, usages, etc., in their intercourses with each other; and the morals of an individual are his or her manners, customs, usages, practices, etc., in relation to one's self and to others. Hence, as the manners and customs of a people react in forming their permanent character, we hear of a good or bad moral character, national as well as individual. As long as mankind has existed so long has he had in some sort, manners, customs, usages, etc., and so the moral world is always co-existent with the physical. But the moral world exists especially in

reference to man; he may be said to have created it for his own purposes; and if by any catastrophe, now unknown to us, the race of man should entirely perish from the earth, one world would perish with him, the moral world which he has created for his own purposes. The original thinker in his first excursions is apt to suppose that that which goes by the name of moral world is not worthy of the name world. What, he says, have not all the lower orders of animals their peculiar habits as well as men: habits, which in the case of some of them, as the beaver, the dog, the mole, and the bee, amount to what might be called manners and customs? Or, is the routine of mankind in their intercourses with each other, in accordance with established rules or laws, called social, political and religious, worthy of the name of world as compared with the physical world? But such an one should bethink himself that the term world (the Greek representative of which is *cosmos*, signifying order, or systematic arrangement) involves the idea of system and order; and the fundamental idea of true morality is order. Thus, the law of Moses, contained in the Ten Commandments, is called the Moral Law, because it contains a system of rules which, if perfectly and universally observed, would ensure the preservation and continuance of order among all human beings.

Thus, the distinction is clearly seen between the physical and moral world; and that, if by any means all mankind ceased to exist, the moral world would cease to exist with them; but the physical world would still remain, and the earth, not an atom of matter less by the disappearance of man from it, would continue to exist, and to revolve upon its axis, and round the sun, and day and night would continue to take place upon it, and the seasons would come and go in succession as they do now, and the changes in nature would continue to take place in their seasons, in the main, always as they now do.

It will be remembered that this is a supposed case only to show man's real importance, if we may so speak, and his real position in existence. But on the other hand, we believe that, if man has always existed, so he will always exist, and so the world he has created, the moral world, will co-exist with him. And, moreover, as he is a changeable being he will continue to change his moral system, modifying it, remodelling it, and creating it anew; as, for example, a nation may do which may change its moral system in part, or may change it in whole, social, political, and religious, every century more or less, and may thus create a new moral world as often as it sees fit. And further, it is the moral principle which chiefly distinguishes man from the brutes, constitutes him a responsible being,

to be depended upon in matters of contract and in all social intercourse, and the adherence to which promotes and elevates nations as well as individuals. The primary idea of morality is divinely good, implying intelligent order in and among human beings; the idea of badness being at all associated with it arises from its perversion. He who lives not according to moral principle makes himself lower than the brutes. The cultivation of the moral principle by precept and example and the enforcement of its observance by requisite compulsion and restraint should be the object and care of just and righteous laws. The importance, then, of the adoption and practice permanently of a good moral system, such as that contained in the "Ten Commandments," and in "the Sermon on the Mount," is here clearly recognized.

Secondly : Character of the Ancient Civilized Nations.

And now let us briefly review the state of moral character of the nations called civilized. Among the ancients, the Greeks and Romans are understood to have been the most civilized nations. They were those which are thought to have attained the highest perfection in art and literature. They were those which, of all the ancients, modern nations most delight to imitate in respect to their arts, literature, and arms. The Greek and Roman languages and literature are taught in our academies and colleges and the laws of Lycurgus and Solon, of Numa and Justinian are studied by our undergraduates. But what information do the records of history afford us as to the moral character of these nations. Wars and intrigues, treachery and oppression, and all sorts of crime comprise most of it. In the earliest periods of which history gives us any information, we find these nations engaged in wars. The war of the Grecian States with Troy, an account of which we have in the "Iliad" of Homer, although it is not recorded in history proper, yet is acknowledged by our ablest modern historians to have taken place. This war, having been prosecuted for ten years, ended in the downfall of Troy; and, though we have no certain information as to the numbers that fell on both sides, yet, judging from the numbers said to have been engaged, we know the loss of life must have been very great. Troy is said, according to the common belief, to have fallen in the year 1184 before Christ. We mention this war to show what we meet with in the very beginnings of Grecian history, and as experience teaches that history repeats itself, we may believe that this war was but a repetition of what had been taking place in prehistoric ages. After this followed the first and second Messenian

wars carried on between Sparta and Messenia for a period of many years, during which many battles were fought with incredible fury and great numbers lost their lives. Then followed the Persian wars, carried on first by Darius the Persian, against the Grecian colonies in Asia Minor, and afterwards by Darius and his successor Xerxes against Greece itself. The great battle of Marathon was fought between the Greeks and Persians in the reign of Darius, in which many thousand Persians were slain. Darius, humbled at his defeat, entrusted, at his death, the prosecution of the war against Greece to his son Xerxes. The army which the latter led into Greece was the most numerous of which we have any account in the annals of history, the largest of the expeditions of the crusades of sixteen centuries afterwards not coming nearly up to it. According to the statement of Rollin, which is founded on the statements of Herodotus, a historian of those times, of Isocrates, and Plutarch, this army consisted of a million seven hundred thousand foot, eighty thousand horse, and twenty thousand men for conducting the carriages and camels. On crossing the Hellespont, the strait which separates Europe from Asia, an addition was made to it from other nations of three hundred thousand, which made his land forces amount to two million one hundred thousand men. His fleet consisted of twelve hundred and seven vessels, each carrying two hundred and thirty men, in all two hundred and seventy-seven thousand six hundred and ten men, which was augmented by the European nations with twelve hundred vessels, carrying two hundred and forty thousand men. Beside this fleet the small galleys, transports ships, etc., amounted to three thousand, containing about two hundred and forty thousand men. Including servants, eunuchs, women, and suttlers, and others who usually follow an army, it is reckoned that the whole number of souls that invaded Greece with Xerxes amounted to five million, and nearly three hundred thousand souls. After remaining some time in Greece, nearly the whole of this vast army, along with the fleet, was routed and destroyed. Mardonius, one of the lieutenants of Xerxes, whom the latter at his departure left to prosecute the war in Greece with three hundred thousand men, was finally defeated and slain by the Greeks at the battle of Plateæ, and only three thousand of this vast army is said to have escaped destruction. This account of the invasion of Xerxes appears on the whole to be somewhat exaggerated.

After this followed the first and second Peloponesian wars between the Greeks themselves, the two leading States, Athens and Sparta, being engaged against each other. These wars were carried on for very many years with varying success, and great loss of life

to both sides. And preceding and following all these there were endless wars and contentions between the petty Grecian States themselves in which were displayed the basest intrigue, perfidy, treachery, dishonesty and animosity. They made truces with each other only to break them when they got a fair opportunity; nor did they lose any occasion which presented itself of inflicting damage on each other when at war, attacking each other at night, and murdering and robbing all they could. And it should be borne in mind that the Greeks were a shrewd, cunning people; they united the cunning and treachery of the fox with the boldness and ferocity of the lion and tiger; and in very numerous individual cases the wisdom of the sage with the courage of the warrior.

The opening history of the Romans also represents that people as engaged in war. The founders of Rome are represented in mythical tradition as descended from the Trojans, who, after the fall of Troy, emigrated to Italy under the leadership of the Trojan chief, Æneas. Romulus and Remus, the descendants of Æneas on their mother's side, and who are represented as having the god Mars for their father, are said to have founded the city, Rome, about the year 753 B.C. In a dispute which arose between the two brothers, as to the name to be given to the new city, Romulus is said to have slain his brother Remus, and so the city was called Rome after the name Romulus. (This, as we have mentioned, is derived from tradition, and is not supported by authentic history; indeed, there are reasons to believe the city, Rome, may have been an old city, before the time it is said to have been founded by Romulus and Remus.) But it goes on to say: The new city being well filled with men who flocked to it from all sides, but there being a scarcity of women, Romulus, in order to obtain wives for his citizen subjects, is said to have made application to the neighboring communities, with that in view: but his proposal being treated with contempt, he resolved to obtain by stratagem what had been denied his honorable request. He invited certain tribes of the Sabines and Latins to come to Rome to witness certain festive games, and when they were assembled his Romans fell upon the daughters of their guests and carried them off by force. In consequence of this Rome became involved in a war with the Sabines, which, however, was brought to an amicable conclusion by the intervention of the women, who threw themselves between the two armies and declared themselves willing to share the fate of their new husbands. After this Romulus is said to have waged successful war against Fidenæ and the Etruscan town of Veii, the latter of which he compelled to give up a portion of its territory. His reign is said to have extended over a period of

thirty-eight years, 753-716 B.C., and his death was as marvellous as his birth; for while he was reviewing his people his father, Mars, descended in a tempest and bore him up to heaven. Under the name of Quirinus he was afterwards worshipped as a god for a period of nearly eleven hundred years, from the time he is said to have lived to the establishment of the Christian religion, in the empire, by Constantine, A.D. 330. The same honors were paid him as to his father Mars, and it was believed that he watched for the interest of the state he had founded. This may have been one cause of the invincibility of the Romans in battle, that they thought themselves watched over, favored, and assisted by the founder of their state. Men often believe a lie as if it were the truth; but firmly, though blindly, believing it, it is as truth to them. Although this account, as that of the war of Troy, is mythical, it nevertheless shows us the warlike practice of these people in early historic times, and as we find them to be at the very beginning of their history, so we may certainly conclude them to have been before.

From the reputed time of Romulus to that of the Sicilian and Carthaginian wars, for a period of between three and four hundred years, the Romans were perpetually engaged in contests with the Italian tribes. The Etruscans, the Latins, the Marsians, the Hermetics, the Æquians, the Pelignians, the Umbrians, the Lucanians, and the Samnites, were all subjugated by Rome. She then proceeded to subdue the Grecian States of Southern Italy, and, after continuing the war for many years, during which time the Romans fought many and hard battles, especially with Pyrrhus, King of Epirus, who had come from Greece with an army to assist these Grecian colonies, Rome finally succeeded in conquering both Pyrrhus and all the Grecian States of Southern Italy, and in establishing her government over these States.

In more modern times we have a counterpart for Rome in the Anglo-Saxon Heptarchy; for after, by conquest or otherwise, the seven Saxon kingdoms were brought under the power of the king of Wessex, their forces being concentrated, they expanded by degrees on all sides, and, under a succession of Norman princes, brought into subjection the remaining parts of South Britain, and eventually Ireland. Scotland was united to the government in after times and by peaceful means. But as Rome did not cease to advance her conquests after she had subdued Italy and Sicily, neither did the Anglo-Saxons, when they had subdued Britain and Ireland; but they advanced in all directions in enterprise and arms, until to-day the sun never sets upon the Anglo-Saxon race and language, and their influence in arts and arms is far more than commensurate with the

countries they inhabit. But the comparison in other respects stands thus,—if in the acquisition of territory, England slew her thousands Rome did her tens of thousands. It is to be hoped that, henceforth, England will take care that she add not largely to her cup of blood by war.

Carthage was originally a colony of Phœnicians who, about the year 800, B.C., settled on the northern coast of Africa. These colonists increased their dominions by inroads on the neighboring tribes, and, being a naval power, by degrees became masters of almost every island in the Mediterranean. Thus Carthage may be truly said to have become great at the expense of her neighbors. Their efforts to conquer Sicily brought them into collision with the now formidable forces of Rome. The conflicts between Rome and Carthage are distinguished in history by the name of the Punic Wars, Punic meaning Phœnician, for Carthage, as we have said, was a Phœnician colony. The first Punic war, beginning B.C., 264, lasted twenty-four years; the second seven, and the third four years and some months. In the last contest the city of Carthage was destroyed to its foundations by the Romans. It was delivered up by Scipio, the Roman general, to be plundered by the soldiers; its gold, silver, statues, and other treasures amounting to 4,470,000 pounds weight of silver were carried to Rome; its towers, ramparts, walls and all the works which the Carthaginians had raised in the course of many centuries, were levelled to the ground. Fires were set to the edifices of the once proud metropolis, which consumed them all; not a single house, it is said, escaped the fury of the flames. And although the fire began in all quarters, and burned with great violence, it continued for seventeen days before all the buildings were consumed. Thus perished a city which contained 700,000 inhabitants, and which had waged so many ferocious wars with neighboring nations—a terrible example of the destructive effects produced by malevolent passions in war, and of the retributive justice of the Governor of the universe. The destruction of human life in the wars which Rome waged with Carthage is beyond all specific computation. During the space of sixteen years Hannibal, the Carthaginian general, sacked no less than fourteen hundred towns, and destroyed three hundred thousand of his enemies, and we may safely reckon that nearly an equal number of his own men were cut off by the opposing Roman armies; so that several millions of human beings must have been sacrificed in these bloody and cruel wars.

The following is a summary statement of the number of human beings that were sacrificed in a few of the battles recorded in history as fought for the most part by the Greeks and Romans against their

enemies. In the battle of Issus, between Alexander the Great, at the head of the Greeks, and Darius the Persian, there are said to have been slain 110,000; in the battle of Arbela, two years afterwards, between the same two despots, 300,000. In the siege of Jerusalem by Vespasian and Titus, according to Josephus, there were destroyed 1,110,000. And there are said to have been slain in Jerusalem in the year 170, B.C., by Antiochus Epiphanes, celebrated for having compelled the Jews to worship his image, which he introduced to their temple, 40,000. In the year 101, B.C., in an engagement had between the Romans under Caius Marius, their consul, and the German tribes of Cimbri and Teutons, in transalpine Gaul, there are said to have been slain of these barbarians, aside from what fell on the Roman side, 200,000 men,—some historians say 290,000; and it is related that the inhabitants of these countries in which the battle occurred, made fences for vineyards out of the bones. In the ensuing year the Romans, under the command of the same consul, slaughtered 140,000 of the Cimbri, and took 60,000 prisoners. In the year 105, B.C., the Romans, in a single battle with the Cimbri and Teutons, lost upwards of 80,000 men. In the battle of Cannæ the Romans were surrounded by the forces of Hannibal and cut to pieces, after an engagement of only three hours the carnage became so dreadful that even the Carthaginian general cried out to spare the conquered. Above 40,000 Romans lay dead on the field, and 6000 of the Carthaginians. What a horrible exhibition of the rage and fury of diabolical passions must have taken place on this occasion; and what a dreadful scene must this field of battle have presented, when we consider that, in the mode of warfare of those days, the slain were literally mangled and cut to pieces! In the battle between Scipio and Hasdrubal 40,000 are said to have fallen. At Cyrene there are said to have been slain of Romans and Greeks, by the Jews, 220,000; in Egypt and Cyprus in the reign of Trajan, 240,000; and in the reign of Hadrian, 580,000 Jews. After Julius Cæsar had carried his arms into the territories of the Usipetes in Germany, he is said to have defeated them with such slaughter that 400,000 perished in one battle. (This most probably is exaggerated.) In the battle of Chalons, between the Huns, under Atilla, and the Romans, there perished about 300,000. In the year 631, A.D. there are said to have been slain by the Saracens in Syria, 60,000. In the invasion of Lombardy and Milan, by the Goths, no less than 300,000. In A.D. 734 by the Saracens in Spain, 370,000. In the battle of Yermuk, 150,000. In the battle between Charles Martel and the Mohammedans, 350,000, at the least computation, are said to have been slain. In the battle of Muret, in

A.D., 1213, between the Catholics and Albigenses, 32,000 are said to have fallen. In the battle of Cressy, between the English and French in 1346, 50,000. In the battle of Halidon Hill, in 1333, 20,000. In the battle of Agincourt, in 1415, 20,000. In the battle of Towton, in 1461, 37,000. In the battle of Lepanto, in 1571, 25,000. In the battle of Fontenoy, 100,000.

The destruction of human life in the wars that accompanied and followed the invasion of the barbarous nations who overthrew the Roman Empire in the West is beyond all specific calculation. In the war which was waged in Africa in the reign of the Emperor, Justinian, Procopius remarks: "It is no exaggeration to say that *five millions* perished by the sword and famine and pestilence." The same author states that during the twenty years war which this Emperor carried on with the Gothic conquerors of Italy the loss of the Goths amounted to above *fifteen millions*; nor does this appear altogether incredible when we remember that in one campaign 50,000 laborers died of hunger.

About the beginning of the thirteenth century arose the very cruel and bloodthirsty tyrant, Zingis Khan. With immense armies, some of them amounting to a million of men, he overrun and subdued the Kingdom of Hya, in China, Tangut, Kitay, Turkistan, Karazum, Great Bucharia, Persia, and part of India, committing the most dreadful cruelties and devastations. It is computed that during the last twenty-two years of his reign no less than 14,470,000 were butchered by this merciless scourge of mankind. He appeared to the people of the East like an infernal fiend, breathing out destruction wherever he went, and the doctrine which he preached after conquest was utter extermination.

About the same time when this monster was ravaging the Eastern world those mad expeditions distinguished by the name of Crusades were going forward in the West. Six millions of infatuated mortals, raging with hatred and thirsting for blood, assumed the image of the cross and marched in successive expeditions, in tumultuous confusion, to the confines of Palestine, in order to recover the city of Jerusalem from the hand of the Mohamedans. In these *holy wars*, as they were impiously called, more than 850,000 Europeans are said to have been sacrificed, before they obtained possession of Nice, Antioch, and Edessa. At the capture of Jerusalem in 1099; about 75,000 are said to have been slain; and at the siege of Acre, 300,000. For nearly two hundred years these wild expeditions continued to go forward, and were urged on by proclamations issued from the papal and kingly thrones, and by fanatical sermons from the pulpit, until several millions of deluded wretches perished from the earth;

for the greater part of those who engaged in the crusades either died from hardships endured on the march or were slain or taken prisoners. At this period, and for many centuries before, the wide expanse of Europe and Asia exhibited little else than one great field of battle, in which nations were dashing against each other, conquerors ravaging kingdoms, tyrants exercising the most awful cruelties, superstition and revenge immolating their millions of victims, and tumults, insurrections, slaughter and universal alarm, banishing peace and tranquillity from the abodes of men, and subverting the moral order of society. The European states were distracted by the incessant disputes between the popes and the emperors; the interior of every European kingdom was torn in pieces by the contending ambition of the powerful barons; in the Mohamedan Empire the caliphs, sultans, and emirs, waged continual war; new sovereignties were daily rising and daily being destroyed, and amidst this universal slaughter and devastation the whole earth seemed in danger of being laid waste, and the human race to suffer an extermination.

In the latter part of the 14th century arose Tamerlane, one of the successors of Zingis Khan. This ruthless conqueror followed in the footsteps of his predecessor, the cruel Zingis. Putting himself at the head of large armies he overran Persia, Turkestan, Kipzak, Russia and Hindostan, ravaging as he went, levelling cities with the dust, cruelly destroying their inhabitants, and committing the most horrible depredations. He also conquered the Turks of Asia Minor and carried the Sultan Bajazet into captivity, as it is said, in an iron cage. Whole nations were crushed under the iron heel of this conqueror. The historian Gibbon when speaking of him says: "The ground which had been occupied by flourishing cities, was often marked by his abominable trophies, *by columns or pyramids of human heads*; and perhaps his conscience would have been startled if a priest or a philosopher had dared to number the millions of victims whom he sacrificed to the establishment of peace and order."* Such is the motive that invaders generally avow for their action—that they may establish order in the nations which they invade—but too often it happens that instead of bringing order and tranquillity they bring to them ruin and devastation. By the Crimean War, carried on between France, England, and Russia, there were killed 784,991. By the Italian war of 1859, 45,000. By the war with Schleswig-Holstein, 3,500. In the American civil war, of the Northern army there were killed 327,184; of the Southern army, 209,000. In the war of 1866 between Prussia, Austria, and Italy, 45,000. In

* Gibbon's Rome.

distant and various wars in Mexico, Cochin China, Morocco, St. Domingo, Paraguay, etc., 65,000; making a total of one million seven hundred and fifty thousand men swept off by war in the space of fourteen years, between 1853 and 1866. And in carrying on these wars it is estimated there was spent at the least calculation, nine thousand five hundred and sixty-five millions of dollars; an amount of money which if put to the use of benefitting humanity, might have transformed the whole moral and social condition of civilized nations for the better. It is said the entire loss of Germany in the late war it had with France was something like 180,000 men, rather more than half of whom are invalided; and it is certain the loss on the part of France was not less but perhaps much greater: and this war was carried on at a corresponding rate of expense.

It may be remembered that the instances we have adduced are only a few circumstances in the annals of warfare. And yet in a few of the instances last stated, we are presented with a scene of horror which includes the destruction of between fifty and sixty millions of the human race, besides the other various kinds of suffering which war entails. Language can scarcely be found strong enough to express the emotions of the mind when it seriously contemplates the horrible scene. And is it not melancholy to reflect that in the present age, which boasts of its improvements in science, in civilization and religion, neither reason, nor humanity, nor christianity, nor benevolence, has yet availed to stop the progress of destroying armies, and to set a mark of ignominy upon the nations that delight in war. To counteract this most irrational and deplorable propensity by every means which reason or humanity can suggest should be the duty of every one who is desirous to promote the present and future benefit of his species.

For our review of the moral character of the civilized nations we have chosen Greece and Rome, and the nations immediately connected with them, as the most fit representatives of ancient times; and in continuing this review we shall confine it to those nations which have arisen out of the Roman Empire, as the fittest representatives of civilization in modern times. It would not answer to choose out any one of these nations as the fittest national representative of civilization in modern times, for each of them would be unwilling to be classed less high in that respect than any of the others. It becomes our duty, therefore, to take a glance at each of them so far as our limits will allow, and see how they appear to stand with respect to moral character.

We have given proof of the warlike dispositions which were displayed in the Greek and Roman empires, and in a few instances

of other nations also that waged war with them and on their borders ; and now it will be well to slightly examine what dispositions are displayed by these modern nations, while at the same time they may be considered in connection with their religious institutions. As to the dispositions displayed by these modern nations, pride and selfishness are prominent characteristics in them all. All these nations are more or less addicted to wars, and pride and selfishness are the prime movers to the wars which they wage.

Russia has proceeded in her career of self-aggrandizement for the last two centuries, absorbing one nation after another against their will, until her dominions now extend across the whole continent of Asia from the China Sea to the Baltic ; and from Mount Caucasus and the frontiers of Tartary to the frozen ocean. Russia has to a large extent made herself great at the expense of her neighbors ; starting from her northern desert, in the time of Peter the Great, she has extended her dominions, until she is now equal in extent of territory to any other nation on the globe. Her government is strictly despotic. Her religion is Christian of the Greek model, which we shall have occasion to speak of in the latter part of the book. The mass of her peoples, until lately serfs, are generally ignorant and of a servile spirit. Her penal laws are exceedingly severe ; the severest punishments are frequently inflicted for the most trivial offences. At the will of the emperor, and often for very slight offences, men are bound in irons and transported to the frozen regions of Siberia, there to drag out a most miserable existence, until death or the term of their banishment puts an end to their sufferings. The knout is one of the most common instruments of punishment used in Russia. This instrument is a thong made of the skin of the elk or the wild ass, and so hard that a single stroke cuts the flesh to the bone. The following description is given by Olearius of the manner in which he saw the knout inflicted on eight men, and one woman, only for the crime of selling brandy and tobacco without a license : "The executioner's man, after stripping them down to the waist, tied their feet, and took one at a time on his back. The executioner stood at three paces distance, and, springing forward with the knout in his hand, whenever he struck the blood gushed out at every blow. The men had each twenty-five or twenty-six lashes ; the woman, though only sixteen, fainted away. After their backs were thus dreadfully mangled they were tied together, two and two ; and those who sold tobacco having a little of it, and those who sold brandy a little bottle put about their necks. They were then whipped through the city of Petersburg, for about a mile and a half, and then brought back to the place of their punish-

ment and dismissed." This is what is termed the moderate knout, for when it is administered with the utmost severity, the executioner striking the flank and ribs, cuts the flesh to the bowels, and therefore many die of this merciless and inhuman punishment. The punishment of the pirates and robbers who infest the banks of the Volga, is another act of savage cruelty peculiar to Russia. A float is built whereon a gallows is erected, on which is fastened a number of iron hooks, and on these the wretched criminals are hung alive by the ribs. The float is then launched into the stream, and orders are given to all the towns and villages on the borders of the river, that no one upon pain of death shall afford the least relief to any of these wretches. These criminals sometimes hang in this manner three, four, and even five days alive. The pain produces a raging fever, in which they utter the most horrid lamentations, imploring the relief of water and other liquids. During the reign of Peter the Great the robbers who infested the various parts of his dominions, especially the banks of the Volga, were hung up in this manner by hundreds and thousands, and left to perish in the most dreadful manner. The boring of the tongue, and the cutting of it out, are practiced yet in Russia as an inferior species of punishment. It is much to be hoped that the time will soon come when governments will see and admit the folly and injustice of such proceedings. Punishment administered beyond the desert of the offence, can have no other tendency than to demoralize the minds of the people, to blunt their natural feelings, and to render criminal characters still more desperate; and hence we need not wonder at what travellers affirm respecting the Russians, that they are very indifferent as to life or death, and undergo capital punishment with unparalleled apathy and indolence. It matters little what the name of the religion is that is professed by a government which practices, or allows to be practiced in its dominions, such tyranny, brutality and cruel barbarism. In order to show itself civilized and a worthy apostle of its faith to foreign peoples, a government should show itself exemplary at home by dealing righteously, benevolently, and beneficently with its own people.

Prussia and Russia may be said to have attained a conspicuous national existence at the same time. In the year 1701 Frederick, the Margrave or Count of Brandenburg, deeming himself strong enough to make good his intentions against the nations which might choose to oppose him, crowned himself king, and publicly announced that his name henceforth was not elector of Brandenburg, but king of Prussia. At the same time Peter the Great was engaged in the work of building the City of St. Petersburg, and of making Russia a naval

power, after having a few years previously prepared himself for this task by practicing as a shipbuilder in an English dockyard. Both of these nations have since then under successive rulers made great advances to power. We have stated by what means Russia enlarged her dominions to such a great extent; and shall we now inquire by what means Prussia has come by her power and attained to the supremacy among the German States which she now enjoys? Was it by peaceable or warlike measures? Mainly by war. True, Prussia owes much for her present eminency to the intelligence of her people; and this is, of course, owing to the system of education that is established and carried on in that country. Now the proper object of a system of education is to diffuse a knowledge of the sciences, the useful arts, and of any other branch of knowledge the acquisition of which may tend to the happiness and well-being of the people. But the system of education established in Prussia includes the teaching of the military art as well as the other arts. And it may probably be argued that the art of war is a necessary and useful one. There is no necessity of it if men but keep the principles of pride and selfishness in their own nature in due subordination to the principles of godliness, which they can do by having right reason rule. Nor can the greatness that is derived from war be called true greatness. What, it may be asked, Is a nation to look on inactively and see itself invaded, desolated, and absorbed by an enemy without offering any resistance? This sometimes would be the wisest policy for a nation in such circumstances. Some of those nations, for example, which have been absorbed by Prussia herself during her career of conquest and by Russia might have done better had they thus acted. Since they were not able effectually to repel, it would have been wiser for them to have submitted to the invader, without actively resisting him, by which course they would at least have saved the lives of those who fell, and perhaps obtained better terms from the aggressor. But if a strong nation is attacked what course should it pursue? Intelligent non-resistance would in this case even be the best course to follow, and by peaceful measures to obtain the best conditions obtainable; it is also by far the most praiseworthy. But each nation, when it feels itself greatly aggrieved by another, no matter how limited its resources for offence and defence are as compared with those of the other, is apt to feel itself equally strong, just as a small weak man feels when he is provoked to combat by a large athletic one. Well, as there is no necessity of either of these men striking the other, nor of the one that may have been struck striking in return, so there is not the slightest need of a nation, whether it may be powerful or weak, striking either in aggression or defence. In-

telligent non-resistance on the part of a nation, as of an individual, makes the aggressor feel ashamed of his conduct, and is the means of saving life and limb and property, and of securing the blessings of happiness and peace to many people who should otherwise suffer. But the question is often and very considerably asked Who, when struck or insulted, can abstain from striking or insulting in his turn? Any one can abstain from it if he will but act **considerately**. If a man returns an insult he degrades himself to the level of him who insults him; but if one try to kill him, he should endeavor to not be killed. Reason should always be allowed to govern; passion or malevolence not for a moment. We have ourselves always acted on the principle of intelligent non-resistance, and mean to do so as long as we live. The principle of good-will to men, men of every character and temper, should be cultivated by all, and no principle contrary to this should be allowed to occupy the breast for a single moment. If men are weak enough to strike or insult, they are so from ignorance or the depravity of their nature; such should be looked upon with compassion, and their good, not their evil and destruction, should by every means be sought; when they come to fully understand what they are, and what they should be and do, they will be strikers and insulters no longer. Example is ever more powerful than precept, in the case of nations as well as individuals. But, as in the case of two men who are about to quarrel, the law holds that one accountable who strikes first, why may there not be an international law established among the civilized nations, which no one nation will be allowed to transgress? But it may be said that transgression of that law would imply the use of compulsory means to enforce obedience to it, and that this means might necessarily be war. If it were stipulated by the international law that all the nations agreeing to it should remain unarmed, that military principles should not be taught nor warlike implements manufactured or retained by these nations, then war could not be the means resorted to in such a case. But it may be said that when a nation would feel inclined to transgress or to secede from the international confederacy it might insiduously import arms and equipments of war from some other nations outside of the league, and so prepare itself to effectually accomplish its object. To prevent the occurrence of such a breach it would be wise for the confederacy to embrace within itself as many as possible of the nations of the earth, even those they would deem uncivilized; to bring all these if possible to live and abide by the stipulations of the international law; so that there might be no place left from whence to import the means and implements of war. Cannot such a state of things be brought about? It

can be effected, first by the civilized nations among themselves; then by their gradually bringing into their confederacy all the other nations. The first step to be taken to this good end is the universal education of the masses of the people high as well as low in every nation, in the principles of self-denial, charity and true humility; and to this end, the principles of military discipline should not be taught in the schools, nor should anything be taught which would tend to foster or cultivate a warlike spirit. There should be no panegyrics delivered by the teachers nor found in the school-books upon the virtues of warriors of past ages or of the present; nor should an Alexander, a Cæsar, a Frederick, a Bonaparte, a Wellington, or even a Washington, so far as he was a warrior, be held up to the admiration or the imitation of the students; only the sciences and the arts which tend to peace should be taught; the principles of pride and selfishness should be not only suppressed but eradicated; and the principles of true virtue, of honest industry, of charity, and intelligent humility, should be universally inculcated and exemplified to the youth. Such a state of things, then, as we have contemplated might be begun to be brought about by the universal education of the masses, commencing with all youth of the present generation; and, as the people would be continually advancing to a higher state of knowledge and civilization, the nations would become more peaceful, stable, and prosperous, would cultivate more the sciences and arts which tend to peace, and would become more closely united to each other in the bonds of charity and mutual good will. We have before explained how that man creates the moral world, and that the great object of a moral system is to enable men to live in association with each other according to order and right. Now this being so that moral system is certainly imperfect, and unworthy of the name of world, which does not provide that men *shall not kill each other* by means of war. It implies not order, but disorder, and all its train of evil consequences. To the end that a better system may be established, and that as universally as possible, much may now be begun to be done by rulers and men of power and influence in all nations, yea and by every teacher, every parent, and every individual both subjectively and objectively. This education, which as we have said is the first step towards the bringing in of a state of things for the better, permanently, must be as universally diffused as possible, and individually subjective as well as objective; for each one must educate him or her self in the principles and practices of self-denial, humility and all the kindred principles which pertain to godliness as well as teach others, as far as one can, the same princi-

ples and practices. Then would love be the motive power to action, instead of, as before, pride and selfishness.

But to return to our main subject, Prussia has to a great extent aggrandized herself, as Russia did, at the expense of her neighbors. It has subdued one nation after another by force of arms ; it has domineered over Austria ; it has humiliated France, and by its course of war and bloodshed it has attained the supremacy in the German States. And in other respects also the moral character of the Prussians is not what it ought to be. It has long enforced a very severe penal code. The following account is given by a traveller, who was in Berlin in 1819, of the execution of a man for murder, which shows that the execution of criminals in Prussia is frequently attended by a species of cruelty worthy of the worst days of the Inquisition : " Amidst the parade of executioners, officers of police, and other judicial authorities, the beating of drums, and the waving of flags and colors, the criminal mounted the scaffold. No ministers of religion appeared to gild the horrors of eternity, and to soothe the agonies of the criminal ; and no supplicatory prayer closed his quivering lips." " Never," says the narrator, " shall I forget the one bitter look of imploring agony that he threw around him, as, immediately in stepping on the scaffold, his coat was rudely torn from his shoulders. He was then thrown down, the cords fixed around his neck, which were drawn until strangulation almost commenced. Another executioner then approached, bearing in his hands a huge wheel, bound with iron, with which he violently struck the legs, arms, and chest, and lastly the head of the criminal. I was unfortunately near enough to witness his mangled and bleeding body still convulsed. It was then carried down for interment, and in less than a quarter of an hour from the beginning of his torture, the corpse was completely covered with earth. Several large stones which were thrown upon him hastened his last gasp ; *he was mangled into eternity.*" Punishments, as we have before said, should not be more than proportioned to the crimes for which they are inflicted, and in every case should be designed for the benefit of the criminal, or of society, or of both. If the life of the criminal is to be taken, the object of the punishment cannot be his benefit ; and no benefit can accrue to society from his being treated with a greater degree of severity than his crime deserves. If the life of the criminal is not to be taken the object of the punishment should be his moral improvement, and the punishment should not be greater than he deserves. An unduly severe criminal code in any country is proof that that nation has yet to advance some degrees before it can be called civilized.

France is a nation which until very lately played an important

part in the history of Europe. From being one of the provinces of the Roman Empire she was raised to the position of an independent state by Clovis in the 5th century, A. D. In the latter part of the 8th century she was raised to a greater height of power by the conquests of Charlemagne; she afterwards lost a great part of the dominions which she had acquired through him, and gained them again after a long interval through the conquests of Napoleon Bonaparte, but only to retain them for a very short time. France, before called Gaul, has as long as we have known her historically, been a nation addicted to war. She has, however, not been remarkably successful in war, never having attained to a very great degree of power, except under the two conquerors just named. Charlemagne is said to have carried on fifty-three campaigns. He was a remarkably ferocious and cruel man. On one occasion, it is said that he beheaded 4,500 Saxon prisoners on the same spot, which may serve as a specimen of the butcheries of this ferocious warrior. This was the man who was crowned by Pope Leo in the church of St. Peter at Rome, in the last year of the 8th century; and who is also inscribed as a Saint of the Roman Church. In him the Roman Empire of the west was considered to have been revived after it had been overthrown and trampled upon for some centuries by the Goths and Vandals, and other northern nations; and from that time till the withdrawal of the French troops from Rome, in the time of Napoleon III., France has almost always been a zealous supporter of the Papacy. We need not here detail the wars of the Bonapartes, their rise, progress, and terminations; they are very generally known, and equal in cruelty and the destruction of human life the battles of ancient times. We shall relate only a few instances of French barbarity in these wars. "After the taking of Alexandria by Bonaparte," says the relater, "we were under the necessity of putting the whole of them to death at the breach. But the slaughter did not cease with the resistance. The Turks and inhabitants fled to their mosques, seeking protection from God and their prophet; and then men and women, old and young, and infants at the breast, were slaughtered. This butchery continued for four hours, after which the remaining part of the inhabitants were much astonished at not having their throats cut." From what follows we can see that all this bloodshed was premeditated. "We might have spared the men whom we lost," says General Boyer, "by only summoning the town; but it was necessary to begin by confounding our enemy." After the battle of the Pyramids, it is remarked by an eye witness, "the whole way through the desert was tracked by bones and bodies of men and animals, who had perished in these dreadful wastes. In order to warm themselves at night

they gathered together the dry bones and bodies of the dead, which the vultures had spared, and it was by a fire composed of this fuel that Bonaparte lay down to sleep in the desert.”* Miot gives the following description of a scene at Jaffa: “The soldier abandons himself to all the fury which an assault authorizes. He strikes, he slays, nothing can impede him. All the horrors which accompany the capture of a town by storm are repeated in every street, every house. You hear the cries of violated females calling in vain for help to those relations whom they are butchering. No asylum is respected. The blood streams on every side; at every step you meet with human beings groaning and expiring, etc.” Sir Robert Wilson, when describing the campaign in Poland, relates, that “the ground between the woods and the Russian batteries, about a quarter of a mile, was a sheet of naked human bodies, which friends and foes had during the night mutually stripped, not leaving the worst rag upon them, although numbers of these bodies retained consciousness of their situation. It was a sight which the eye loathed, but from which it could not remove.” In Labaume’s “Narrative of the Campaign in Russia,” we are presented with the most horrible details: “palaces, churches, and streets enveloped in flames; houses tumbling into ruins, hundreds of the blackened carcasses of the wretched inhabitants, whom the fire had consumed, blended with the fragments; hospitals containing 20,000 wounded Russians on fire, and consuming the miserable victims; numbers of half-burnt wretches crawling among the smoking ruins; females violated and massacred; parents and children half-naked, shivering with cold, flying in consternation with the remains of their half-consumed furniture; horses falling in thousands, and writhing in the agonies of death; roads covered for miles with thousands of the dying and the dead, heaped one upon another, and swimming in blood, and these dreadful scenes rendered still more horrific by the shrieks of young females, of mothers, and children, and the piercing cries of the wounded and the dying, invoking death to put an end to their agonies.” It is probable that some of our readers have been so affected by the description already given, that they have turned away their eyes in disgust from such an appalling spectacle of suffering and horror, but these are only a few instances out of thousands which the authentic histories of the French wars present before us. What untold sufferings have been caused by the wars which France has carried on in our own day! Wars with Russia, with Austria, with Prussia, and last the fratricidal war which was waged at Paris between its own citizens at the

* Miot’s Memoirs. Denon’s “Travels in Egypt” with Napoleon.

termination of the late war with Germany. Yet France has long been considered a leading civilized nation of Europe. The French nation have been characterized as a vain, immoral, and licentious people, in their social state, especially the inhabitants of their chief cities; and these their sins may have sometimes brought destruction upon that people; but we are aware that the suffering and destruction of the many are often caused by the pride and selfishness of a few, very often by the will of an individual, as we believe that last war with Germany may have been which humbled France to the dust and caused such immense loss and suffering to her people.

The penal code in France has also been extremely severe. The execution of Damiens in 1757, for attempting to assassinate Louis XV., was accompanied with tortures, the description of which is enough to harrow the feelings of the most callous nature, tortures which could scarcely be exceeded in intensity, even though they were invented by an infernal fiend; and yet they were beheld with a certain degree of apathy by a surrounding populace, and even counsellors and physicians could talk together deliberately about the best mode of tearing asunder the limbs of the wretched victim, with as much composure as if they had been dissecting a dead subject or carving a fowl.

France has also distinguished itself for its massacres on account of religion. Of these, that of the French Protestants, on the Feast of St. Bartholomew, August 24, 1572, was perhaps, one of the most diabolical acts of perfidy and cruelty which have stained the character of that nation. Everything connected with this unexampled conspiracy and assassination was atrocious and horrible. Ties of the most sacred nature were violated; superstitious zeal was changed into an impious frenzy; and filial piety degenerated into sanguinary fury. Under the direction of the infamous Duke of Guise, the soldiers and the populace, *en masse*, at the signal of the tolling of a bell, flew to arms, seizing every weapon that came in their way; and thus rushing in crowds to every quarter of the city of Paris, no sound was heard but the terrible cry, "Kill the Huguenots." Every one distinguished for being attached to the reformed faith, without any distinction of rank, age or sex, was indiscriminately massacred. The air resounded with the horrid cries and blasphemous imprecations of the murderers, the piercing shrieks of the wounded and the groans of the dying. Headless trunks were every moment thrown into the court-yards or the streets, the gateways were choked up with the bodies of the dead and dying, and the streets presented a spectacle of mangled limbs and human beings, dragged by their butchers in order to be thrown into the Seine. Hotels and public buildings were

reeking with blood : death and desolation reigned on every side, and in all quarters carts were seen loaded with dead bodies, destined to be cast into the river, whose waters were for several days polluted with tides of human gore. The infuriated assassin, urged on by the cry that " it was the King's will that the very last of this race of vipers should be crushed and killed," became still more furious in the slaughter ; in proof of which one Cruce, a jeweller, displaying his naked and bloody arms, vaunted aloud that he had cut the throats of more than four hundred Huguenots in one day. The number of victims thus slaughtered in the city of Paris amounted to about 6000 ; and in the provinces, at the same time, perished about 60,000 souls. The news of this massacre was welcomed at Rome with the most lively transports of joy. The Cardinal of Lorraine gave a large reward to the courier, and interrogated him in such a manner upon the subject as plainly to indicate that he had been previously aware of the intended catastrophe. Cannons were fired, bonfires were kindled, and a solemn mass celebrated at which Pope Gregory XIII. assisted, with all the splendor which the Papal Court was accustomed to display on the happening of events the most significant and of the most important consequences.*

In the civil wars on account of religion in France, in the early part of the seventeenth century, it is computed that about a million of men lost their lives ; and nine cities, 400 villages, 2000 churches, and 10,000 houses were burned and destroyed during their continuance, besides the many thousands of men, women and children, which were cruelly butchered ; and 150,000,000 livres were spent in carrying forward these slaughters and devastations. It is said of Louis XIII., who prosecuted these wars, by one of his biographers and penegyrists, Madame de Motteville, that " what gave him the greatest pleasure was his thought of driving heretics out of the kingdom, and thereby purging the different religions which corrupt and infect the Church of God."

But France has distinguished herself for a fanatical persecuting spirit as well in an atheistical as in a religious or superstitious point of view. The first revolution in France, in 1789, was a revolution not merely in politics and government, but in religion, in manners, and in the common feelings of human nature. It is stated on good authority that a little before this revolution a numerous assembly of *French Literati* being asked in turn at one of their meetings by their president, " whether there was any such thing as moral obligation, answered in every instance that there was not."

* Memoirs of Henry the Great.

Soon after that revolution the great body of the French infidels who then ruled the nation not only denied all the obligations which bind us to truth, justice, and kindness, but pitied and despised, as a contemptible wretch, that man who believed in their existence. Atheism was publicly preached and its doctrines disseminated among the mass of the people. A professor was even named by Chaumette to instruct the children of the state in the mystery of Atheism. De La Metherie, the author of a philosophical journal, when discussing the doctrine of crystallization, made the monstrous assertion, "that the highest and most perfect form of crystallization is that which is vulgarly called God." In the National Convention, Gobert, Archbishop of Paris, the Rector Vangirard, and several other priests, abjured the Romish religion, and for their abjuration they received applause, and the fraternal kiss. The convention decreed that all the churches and temples of religious worship, known to be in Paris, should be instantly shut up, and that every person requiring the opening of a church or temple should be put under arrest as a suspected person and an enemy of the State. The consequences of the universal operation of such principles, and such a high-handed course of procedure on the part of those in authority, were such as might have been expected. They are written in characters of blood. A scene of inhumanity, cruelty, malignity and insatiable rapacity was presented to the world, which excited in the mind of every virtuous spectator amazement and horror. Savage atrocities were committed, which would have been shocking in the most barbarous and unenlightened age; and perhaps at no time in no country was there more licentious practices and more degeneracy displayed. The ties of friendship were severed, the claims of consanguinity disregarded, and a cold-blooded selfishness prevailed the great mass of society. "The kingdom appeared to be changed into one great prison; the inhabitants converted into felons, and the common doom of a man commuted for the violence of the sword and the bayonet, and the stroke of the guillotine." Such was the rapacity with which destruction was carried on that, in the short space of ten years, not less than three millions of human beings are supposed to have perished in that country, chiefly through the out-working of the malevolent principles of the human heart, and the seduction of a false philosophy. The following is a brief sketch of some of the scenes to which we allude, drawn by one who was an eye-witness and an actor in several parts of that horrible drama: "There were," says this writer, "multiplied cases of suicide, prisons crowded with innocent persons, permanent guillotines, perjuries of all classes, parental authority set at nought, debauchery encouraged by an allowance for those called

unmarried mothers, and six thousand divorces in the city of Paris within a little more than two years; in a word whatever is the most obscene in vice and most dreadful in ferocity.* Notwithstanding the incessant shout of "liberty and equality," and the boasted illumination of philosophy, the most cruel persecutions were carried on against all those whose religious opinions differed from the system adopted by the State. While infidelity was in power it wielded the sword of vengeance with brute ferocity against the priests of the Romish Church, who were butchered wherever found, hunted as wild beasts, frequently burned alive, or drowned in hundreds together, without accusation or trial. At Nantes, 360 priests are said to have been shot, and 460 drowned. In one night 58 were shut up in a barge, and drowned in the Loire; 292 priests were massacred during the bloody scenes of the 10th of August, and the 2nd September 1792; and 1135 were guillotined under the government of the National Convention, from the month of September, 1792, until the end of 1795; besides vast numbers who, hunted by the infidel republicans like owls and partridges, perished in different ways throughout the provinces of France. The bloody scenes which have been enacted in Paris in our own day, when Darboy, the archbishop, and several priests, besides thousands of other people, were killed by the Communists and Nationalists in their mutual struggle, correspond to the scenes we have just depicted. And the fact of these infidels or atheists, when they came into power, carrying on such violent persecutions plainly shows that the persecuting spirit is not confined to one sect, be they called papist or atheist, but is simply the working out of the evil principle in man. Men, however, are always inclined to leave the blame of their diabolical actions upon other things than themselves, often upon mere names or ideas. We gather also from the foregoing history of the reign of atheism in France, that, when a nation becomes too enlightened for its established religion or superstition, it is sometimes apt to discard it altogether, and to adopt a system of principles the opposite to those of the old. The same thing takes place in the case of individuals. There is danger in such a course, and there hardly ever is any necessity of adopting extreme opinions upon one side or the other. Changes in the moral world, as in the natural take place gradually. A plant does not come to maturity in a moment nor a child to manhood in a day. Time is required for the intelligent adoption of a creed both by an individual and a nation; and the truth is best arrived at and maintained by preserving the mean between opposite extreme opinions. A national religion

* Gregoire.

should not be discarded by the state until a better substitute can be made for it; and the new system if established should receive the moral support and protection of the government of the state; if not established as in republics, where all religions are equally tolerated, but yet has become so generally prevalent as virtually to supplant the old, it should receive at least the moral support and protection of the government. Violent changes in any department of the moral world are productive of disorder; and since, as we have said before, the fundamental idea of morality is order, when a change in any department of the moral system is required, not only the change itself but the best manner in which the change can be brought about is to be considered by those who are to effect it. The object of government is not only to preserve order among the people but also to subserve and advance their interests and highest good; and the necessity of the worship of the Deity being generally recognized as conducive to the happiness and order of the people, governments may well give their moral support and protection to that system of religion which combines simplicity with truth, and which can be practiced most intelligently by the masses of the people.

As corroborative of the idea advanced with respect to the licentious character of the French, especially the Parisians, we extract the following from Sir Walter Scott's visit to Paris in 1815.

"The Palais Royale, in whose saloons and porticoes vice has established a public and open school for gambling and licentiousness, should be levelled to the ground with all its accursed brothels, and gambling houses, rendezvous the more seductive to youth as being free from some of those dangers which would alarm timidity, in places of avowedly scandalous resort. In the Salon des Etrangers, the most celebrated haunt of this Dom-Daniel which I had the curiosity to visit, the scene was decent and silent to a degree of solemnity. An immense hall was filled with gamesters and spectators. Those who kept the bank and managed the affairs of the establishment were distinguished by the green shades they wore to preserve their eyes, by their silent and grave demeanor, and by the paleness of their countenances exhausted by their constant vigils. There was no distinction of persons nor any passport required for entrance save that of a decent exterior; and on the long tables which were covered with gold, an artizan was at liberty to hazard his week's wages, or a noble his whole estate. Youth and age were equally welcome, and any one who chose to play within the limits of a trifling sum, had only to accuse his own weakness, if he was drawn into deeper or more dangerous hazard. Everything appeared to be conducted with the most perfect fairness. The only advantage pos-

sessed by the bank, which is, however, enormous, is the extent of the funds by which it is enabled to sustain any reverse of fortune; whereas most of the individuals who play against the bank are in circumstances to be ruined by the first succession of ill-luck: so that ultimately the small ventures merge in the stock of the principal adventurers, as rivers run into the sea. The profits of the establishment must indeed be very large to support its expenses. Besides a variety of attendants who distribute refreshments to the players gratis, there is an elegant entertainment with expensive wines, regularly prepared about three o'clock in the morning for those who choose to partake of it. With such temptations around him, and where the hazarding an insignificant sum seems at first venial or innocent, it is no wonder that thousands feel themselves gradually involved in the vortex whose verge is so little distinguishable, until they are swallowed up with their time, talents, fortune, and frequently also both body and soul. This is vice with her fairest vizard; but the same unhallowed precinct contains many a secret cell for the most hideous and unheard of debaucheries; many an open rendezvous of infamy, and many a den of usury and treason; the whole mixed with a vanity fair of shops for jewels, trinkets, and baubles that bashfulness may not need a decent pretext for adventuring into the haunts of infamy. It was there that the preachers of revolution found, amidst gamblers, desperadoes and prostitutes, ready auditors of their doctrines, and active hands to labor in their vineyard. It was here that the plots of the Bonapartists were adjusted; and from hence the seduced soldiers, inflamed with many a bumper to the health of the exile of Elba, under the mystic names of Jean de l'Epée, and Corporal Violet, were dismissed to spread the news of his approaching return. In short from this central pit of Acheron, in which are openly assembled and mingled those characters and occupations, which in all other capitals are driven to hide themselves in separate and retired recesses; from this focus of vice and treason have flowed forth those waters of bitterness of which France has drank so deeply." Now if such a state of things as is here set forth existed at headquarters, right in the departments of the Royal Palace, what must we think existed in other and less public places in Paris, and in France? The great mass of people are generally imitative, inclined to follow the example set them in high places.

It has been the custom in the French Capital to register large numbers of public women who were made to pay from 25 to 50 dollars each, monthly, according to their rank, beauty or fashion. 1552 kept mistresses were noted down by the police; 380 brothels licensed

by the prefect, and 12,076 public women were registered in the year 1803. From the number of divorces it appears that marriage was looked upon as a mere temporary connection from which the parties might extricate themselves when they pleased, and illegitimate children, especially in Paris, are numerous beyond what they are in any other city. It seems hardly conceivable that a government should debase itself to authorize the practice of such licentiousness as is here represented, and to derive a large revenue from such infamous and polluted sources. No government which authorizes or countenances such practices may expect to thrive or be perpetuated. Such practices enervate a people, yea, destroy them body and soul. They are sure to bring down upon the nation in which they exist, sooner or later, the retributive justice of the Governor of mankind. May it not truly be said that the humiliation to which France was subjected at the termination of the first empire and in the late war with Germany, when her whole armies were taken into captivity, which was succeeded by the mutual slaughter of her own people at Paris, were so many visitations on this people for their wickedness? They doubtless were. And not only that, but we fail to see that the sympathetic refinement, which is derived from a too free intercourse of the sexes with each other, while unmarried, is worthy of the name of civilization. It is altogether too contemptible and base for the name. Men and women should deny themselves if they cannot afford to live in honorable marriage. And men and women, be they young or old, should prefer to live on the humblest fare and clothed with the coarsest garments, even though their means were sufficient to afford them a daintier kind, rather than practice luxurious living, or any species of licentiousness, or squander their time and talents which they possess in a too free intercourse with each other. Thus from the review we have been able to give of the moral character of the French, as indicated by their history, it is evident that though they are esteemed a civilized nation they are yet far behind true civilization, and that, if they ever attain a high national character for morality, they will have to alter radically and completely their present moral principles and practices.

In taking a review of the moral character of the Spaniards, as indicated by their history, we find it a good deal as we have found it in the case of the French. From the earliest historical records we have of Spain we find that country to have been the scene of savage warfare, on which the most ferocious passions were displayed. There the Romans, the Goths, the Vandals, the Moors, and the Arabs, fought and reigned at different periods. During certain periods of her history, Spain possessed great power as a nation, and, as France, she

attained her power by war, and lost it in the same way. In the employment of war, and otherwise, the Spaniards have displayed the most savage ferocity, and the most brutal as well as the most refined and exquisite cruelty. Spain has always been the champion of the Romish religion, and in this country that diabolical tribunal of the Inquisition was firmly established and manipulated. Considering indeed, the inhuman and refined cruelties which have been practiced by Spain on account of religion or superstition, that country may, with propriety, be called the peculiar seat of Satan. In the Netherlands alone, from the time that the edict of Charles V. was promulgated against the reformers, more than 100,000 persons were hanged, beheaded, buried alive, or burned, on account of professing the reformed religion. The prisons were crowded with supposed heretics, and the gibbet, the scaffold and the stake filled every heart with **terror**. The duke of Alva, Spanish general to the Netherlands, and his bloodthirsty tribunal, spread universal consternation throughout the provinces; and though the blood of 18,000 persons who in five years had been given up to execution for heresy, cried for vengeance on this persecutor, and his abettors, yet they gloried in their cruelty. Philip II., in whose reign these atrocities were committed, hearing one day that thirty persons had a little before been burned at an *Auto da Fè* (Act of Faith), required that a like execution should be performed in his presence; and he beheld with joy forty victims devoted to torments and to death. One of them, a man of distinction requested a pardon: "No," replied he coolly, "were it my own son I would give him up to the flames, if he obstinately persisted in heresy."

The atrocities which the Spaniards committed on their conquests of some of the West Indian Islands, Mexico, and Peru, are almost beyond credibility that they should be performed by man, if we did not otherwise know the character of that people. The island of Hispania was their first settlement in the new world. They forced the inhabitants to labor as slaves for them digging gold, and, when the object of their cupidity was exhausted, they exterminated them, and the other natives most barbarously. Of two millions of inhabitants which the island contained when discovered by Columbus in 1492, scarcely 150 were alive in 1545, only about fifty years afterwards. The conquest of Mexico by Cortez and his followers was marked with equal horrors. During their whole progress through that country the route of the Spaniards was marked with carnage, injustice, perfidy, and deeds of atrocious cruelty. On one occasion sixty caciques or chiefs of the Mexican Empire, and 400 nobles were burned alive with the utmost coolness and deliberation; and, to com-

plete the horrors of the scene, the children and relations of the wretched victims were assembled and compelled to be spectators of their dying agonies. On another occasion when the inhabitants of the city of Mexico were dressed in their richest decorations, under a pretence of a pretended conspiracy, the Spaniards, in order to seize upon their valuable ornaments, fell upon them unsuspecting, and slaughtered 2000 of the nobles. Every right was violated by the Spaniards, which is generally held sacred by hostile nations. On every trivial occasion the natives were massacred in great numbers, their lands apportioned among the Spaniards, the inhabitants reduced to the condition of slaves, and forced to labor, without payment, on all their public works, while the officers, distributed into different provinces, imitated all the excesses and barbarities of their avaricious commander.

In the siege of Mexico alone no less than 100,000 natives are said to have fallen by the sword, besides those who perished by famine and other causes connected with warfare; but, in their retreat from the capital, the Spaniards suffered a just retribution for their enormities, for numbers of them were butchered by the enraged Mexicans, and those who were taken alive were carried off in triumph to the temples, and sacrificed, with all the cruelty which revenge could invent, to the god of war, while their companions at a distance heard their dismal screams and piteous lamentations.

Equal atrocities were committed in the expedition of Pizarro to Peru. In order that they might obtain the golden treasures of this country, they resorted to the basest treachery, and exercised the most cold blooded cruelties. Under the fairest professions of amity they seized upon the Inca or Emperor of Peru, who had received them in a friendly manner and had commanded his attendants to offer the strangers no injury, and slaughtered, with deliberate and unrelenting fury, above 4000 of his attendants, who never offered the least resistance, after which they passed the night in the most extravagant exultation over the plunder they had acquired from the bodies of the slain. The Inca, in order to regain his liberty, promised them as many vessels of gold as would fill an apartment 22 feet long, 16 feet wide, and 8 feet high, and, after having collected the promised treasure from all parts of his kingdom, and fulfilled his agreement, they not long after, under the most frivolous pretext, condemned him to be burned alive. The booty they acquired by such atrocious means amounted to about ten millions of dollars in gold. The day appointed for the division of this prey was the festival of St. James, the patron saint of Spain; and, although assembled to divide the spoils of an unoffending people, obtained by treachery, cruelty and

slaughter, they had the hypocrisy and audacity to commence the transaction with a solemn invocation of the name of God, as if they expected heaven's blessing to descend upon the wages of their iniquity. It would be difficult to conceive that any beings exist in any region of the universe with worse moral character than these Spaniards proved themselves to be; and it shows what an ineffably bad being man is capable of becoming when he chooses to work out the evil principles of his nature, and to give reins to his depraved passions and propensities. Here, indeed, we find the one characteristic extreme, that of badness; let us see before we finish our review of the nations called civilized, whether we shall be able to find the other extreme, that of goodness; for in the beginning of this review we stated that the two extremes exist in principle in man, either of which he may develop if he chooses, to an almost unlimited degree.

The savage practice of bull-fighting which was long in vogue in Spain, and which fascinated all classes from the prince to the peasant, presented spectacles of suffering of animals and men at which one may be allowed to shudder. It is said they were prohibited in 1805, to the deep regret of the most numerous part of the nation, and that another entertainment, an image of the bull-fight, was substituted in their place, and is still in some places retained. The bull-fights may be said to have represented the gladiatorial shows which were held at Rome, and in the principal cities of the Roman empire for many centuries; in which gladiators (swordsmen) trained for the purpose—for the most part slaves or prisoners of war—fought with wild beasts for the entertainment of the people, who, in great numbers, surrounded the amphitheatre. These gladiatorial exhibitions were abolished by the Emperor Honorius, in A.D. 404.

The cruel practice of the bull-fight does not argue a high state of civilization for the nations that delight in it. Under an impression of his great superiority in the scale of being, over the brute creation, man has always been accustomed to treat the lower orders of animals with excessive cruelty. This, however, does not seem so much to be wondered at since he is so cruel to his own kind; it is all the working out of the evil principle within him. We may assume with certainty that the sufferings of these bulls and horses, wounded and dying, were quite as intense and exquisite, as were those of the wounded and dying men. And these animals were equally worthy of pity, if not more so, since they were not the cause of their sufferings, which was altogether unnecessary, and could as well have been avoided, and since they could not speak to make their sufferings known. Men should remember that the lower orders of animals have

feelings as they have themselves, and are susceptible in most cases, if not all, of as exquisite pain and suffering. We are often very much affected at seeing animals, especially horses, treated with such inconsideration and cruelty. They are made to draw too heavy loads, to travel too fast and to work too long hours, upon, perhaps, a scanty allowance of food by men who seem as thoughtless as they are themselves and infinitely more cruel. We have been a short time ago in a large city where the practice is to a great extent to yoke but one horse to a hack, which in all other cities with which we are acquainted is accustomed to be drawn by two horses, and still this horse is made to travel equally fast up and down hill, and to draw equally heavy loads (as many as they can get into the carriage), as if there were two horses attached. When men come to know what they really are, and that all other animals have feelings as well as themselves, and are as susceptible of pain and suffering; that they are always under the Creator's eye, who is everywhere present to see and know what they do; and that they are accountable for the manner in which they treat these animals which he has entrusted to their care, which are also His creatures, they will then recognize the propriety, as well as necessity, of treating their animals more considerately and better than they have generally hitherto been accustomed to treat them.

The empire of Austria has long been a leading state in Europe. Until the ascendancy of Prussia in our day she had the pre-eminence among the German States. Like Russia and Prussia, in later times, she made herself great at the expense of her neighbors, absorbing one neighboring state after another until she attained her present dimensions. She comprises in her dominions various nations and languages, and her people generally are less enlightened than are the other German nations. The prevailing religion in Austria is that of Rome, and this nation like France has always been a stout supporter of the Papacy. As that state rose out of part of the Roman Empire, and has always been under the influence of Rome, most that will be necessary to say here with regard to its moral character is that it partook of the character of the Roman Empire in its two aspects of civil and religious, and the character of the Roman Empire we shall have to speak of more fully in the latter part of this book. Savage warfare has always there been practiced; the principles of the Inquisition have there been carried out; and the Romish Church, as in other European states, has for many centuries there held sway both over the souls and bodies of men. So that in our review of the moral character of Rome, which will have especial reference to the doings of the Roman Church, we may have

glimpses of that of Austria, as Austria since her rise has always been a principal member of that Church.

The modern Kingdom of Italy has very lately been formed. From a comparatively limited extent of territory, comprised in the state of Sardinia, Victor Emmanuel, with the assistance of some able and talented statesmen, has extended his dominions over all Italy. He has even added the Papal States to his dominions and made the city Rome his national capital. He is a man who (whatever his secret motives may have been, they are best known to himself), for doing so well for his people and for humanity at large, in the circumstances in which he was placed, is entitled to the consideration and respect of all civilized nations, and of all good people. Much fault has been found with him by Roman Catholics for having appropriated the Papal States; but in appropriating the Papal dominions he only took away from the Pope what did not belong to the Pope, and what, according to the voice of the people, the Pope was misgoverning, and restored to the Kingdom of Italy its ancient capital. The Popes have been accustomed to claim the Papal States and the city Rome as their dominions by right of donation by Constantine, which donation they claimed to have been confirmed nearly five hundred years after by Charlemagne. But history goes to prove the said donation of Constantine to have been a fiction, most probably of the eighth century, and its confirmation by Charlemagne to have been no better; for although both Pepin, the father of Charlemagne, and Charlemagne himself had pretended to make gifts and promises to the Popes of these dominions, yet Charlemagne at his death reckoned the city of Rome and the territories nominally governed by the Pope as part of his dominions; of this we may have occasion to speak again in the latter part of this work. The Pope, therefore, had no right to the dominion of Rome except the right of possession; and the vote taken in the Papal dominions to ascertain the will of the people on the subject plainly proved that they wished the government transferred to the King of Italy. It was then a matter of duty as well of right for him to assume the government of the Papal dominions. It is much to be hoped that he will proceed even farther in his laudable course, and, as he has been the liberator of Italy civilly, become also its liberator religiously from the shackles of Popish or Romish idolatry. The Italians only need to become more generally and liberally educated in order to fit them for this more perfect freedom. But to this universal education they need to be encouraged, and assisted, and as in Prussia, required to attend by the government. In time past in that country education was not only not permitted or encouraged, put positively interdicted. A

royal Sardinian edict, published in 1825, "directs that henceforth no person shall learn to read or write, who cannot prove the possession of property above the value of 1500 livres (about 300 dollars). The qualification for a student is the possession of an income to the same amount." The people of Italy, as well as those of the other European states, have too long been prevented from education, and kept enslaved, body and mind, by the diversified machinery of the civil and religious power of the Catholic church. But Italy, as the other European states, is a warlike power, and maintains a large standing army; yet it is hoped that, in the process of time, when her people have become enlightened by education and true religion, Italy, which has been the scene of so many conflicts, and has drunk the blood of so many myriads of the human race, shall become a peaceful nation; her government joining heartily with the other civilized nations in disbanding their armies and police, and in inaugurating and maintaining a reign of peace and righteousness in the world. There is much to be done, and some time will be required, in bringing the people of Italy, as well as of the other European nations, to that degree of enlightenment and civilization which we wish they had now attained. The sooner the movement is made in the direction we have indicated, and persistently carried out, the sooner will this great end be attained. The present and future rulers of Italy and of each of the other European states may, if they but will, do much toward the enlightenment and highest good of their people.

England is a nation of great power and influence. If it be enquired by what means this nation has come by her dominions, it may be answered that it was mainly by force of arms. The seven states of the Saxon Heptarchy waged war among themselves. After they had become united and their power became concentrated, England, under the Norman and other princes, carried on destructive wars with Scotland, Wales, Ireland and France, in the last-named country of which she maintained her power for some centuries. Scotland, however became united to England in more modern times and by peaceable means; and the rise of the English power to its present state has been mainly accomplished since the union of these two countries nearly three centuries ago, since when the united nation has been called Great Britain. By her conquests on sea she has secured the possession of extensive colonial territories, and by the maintenance of a great naval power she retains them. England's naval wars have been destructive of life, and very fertile in the increase of her power. Her wars with France, with the Dutch, with her own colonies in America, with Russia, with India and China, have been ferociously

carried on, and with great loss of life and property to the people of these countries as well as to herself. By savage warfare, then, England has attained and maintains her power and influence among the nations of the earth.

Without adverting to the oppressive landlord and tax system which is in practice in great Britain and Ireland, by means of which the great mass of the people cannot do much more in the acquisition of wealth than obtain a bare subsistence, in order the better to illustrate the moral character of Great Britain as a nation, we shall bring forward one or two instances of the manner in which she accumulated her wealth.

In another age it will perhaps scarcely be believed, and in this age it is very little known, that Great Britain, distinguished for her zeal in propagating Christianity throughout the heathen world, has for many years derived a revenue from the worship of the idol Juggernaut, and other idols of similar description at Gya, Allahabad, Trepetty, and other places in Hindostan. From the year 1813 to 1826, there was collected, by order of the British Government, from the pilgrims of Juggernaut alone about 1,360,000, rupees or \$850,000, a great part of which was given to the support and maintenance of the abominable worship of this idol. Dr. Buchanan, in his "Christain Researches," states, from official accounts, that the annual expense of the idol Juggernaut presented to the British Government is as follows:

	RUPEES.	DOLLARS.
Expenses of the table of the idol.....	86,115	or 22,570
Expenses of his wearing apparel.....	2,712	or 1,695
Wages of his servants.....	10,057	or 6,295
Contingent expenses at the different seasons of pilgrimage....	10,989	or 6,865
Expenses of his elephants and horses.....	3,030	or 1,890
“ of his annual state carriage or car, and tower of the idol.....	6,713	or 4,195
	Rup. 69,616	\$48,510

Forty-three thousand five hundred and ten dollars, paid annually by the British Government for the support of one idol, Juggernaut! Some of our readers will say they never expected that Britain, which has displayed so much zeal in the dissemination of Bibles and Testaments and Tracts and orthodox Christain doctrine, would be guilty of any such practice. In the item "wages of servants" is included the wages of the courtesans that are kept for the service of the temple.

Mr. Hunter, the collector of the pilgrim tax for 1806, told Mr. Buchanan that three state carriages were decorated that year at an expense of upwards of one thousand dollars, with English broadcloth

and baize. The following items show the gain of this association with idolatry at some of the principal idol stations in India :—

	RUPEES.
Net receipt of Pilgrim tax at Juggernaut for 1815	135,667
“ “ at Gya for 1816	182,876
“ “ at Allahabad for 1816	73,053
“ “ at Kashee-poor, Surkuree, Sumbal and Kawa, 1816	5,083
“ “ at Tripetty and Madras for 1811	152,000
	<hr/> 549,279

A rupee, though generally considered to be only of the value of half a crown or about sixty cents,* is said to be received in the case of the pilgrims of India as equivalent in value to one pound sterling or five dollars to an inhabitant of England; so that in this point of view rupees may be considered as equivalent to pounds sterling or five dollar pieces.

Mr. Hamilton, in his “description of Hindostan,” as quoted by Mr. Peggs in his “Pilgrim Tax in India,” states, with respect to the district of Tanjore, that “in almost every village there is a temple with a lofty gateway of massive architecture, where a great many Brahmins are maintained partly by an allowance from government. The Brahmins are here extremely loyal on account of the protection they receive, and also for an allowance granted them by the British Government, of 45,000 pagodas or 18,000 pounds annually, which is distributed for the support of the poorer temples.” One can scarcely conceive of anything more inconsistent than the conduct of a nation, that professes itself to be Christian and will not allow that it is idolatrous, supporting a system of idolatry the most revolting, cruel, lascivious and profane? Yet a member of the British Parliament, C. Bullen, Esq., in his letter to the Court of Directors relative to Juggernaut in 1813, says: “I cannot see what possible objection there is to the continuance of an established tax, particularly when it is taken into consideration what large possessions in land and money are allowed by our government in all parts of the country for keeping up the religious institutions of the Hindoos, and the Mussulmans.” From all parts of India multitudes of idol-worshippers or pilgrims annually travel many hundred miles to pay homage to the different idols alluded to above. A tax is levied on those pilgrims graduated according to the rank or circumstances of the pilgrim, and amounting from one to twenty or thirty rupees. Those travelling to Allahabad, for example, are taxed at the following rates; on every pilgrim on foot, one rupee; on every pilgrim with a horse or a palanquin, two rupees; on every pilgrim with an elephant, twenty

* This is the silver rupee; the gold rupee is valued at 29s. 2d. = \$7.00.

rupees, etc. Vast numbers of deluded people flock to these temples every year.

In 1825, the number that arrived at Juggernaut was estimated at 225,000, and in some years they have been calculated to amount to more than a million. The deprivations and miseries endured by these people are almost inconceivable. Dr. Buchanan, who visited the temple of Juggernaut in 1806, gives the following statement: "Numbers of pilgrims die on the road, and their bodies generally lie unburied. On a plain near the pilgrim caravansera, one hundred miles from Juggernaut, I saw more than one hundred skulls; the dogs, jackals, and vultures seem to live here on human prey. Wherever I turn my eyes I meet death in one shape or other. From the place where I now stand, I have a view of a host of people, like an army, encamped at an outer gate of the town of Juggernaut, where a guard of soldiers is posted to prevent them from entering the town until they have paid the tax. A pilgrim announced that he was ready to offer himself a sacrifice to the idol. He laid himself down on the road before the car as it was moving along with his arms stretched forward. The multitude passed him leaving the space clear and he was crushed to death by the wheels. How much I wished that the proprietors of Indian stock would have attended the wheels of Juggernaut, and seen this peculiar source of their revenue. I beheld a distressing scene this morning in the place of skulls, a poor woman lying dead or nearly so with her two children by her, looking at the dogs and vultures, which were near. The people passed by without noticing the children. I asked them where was their home, they said they had no home, but where their mother was. Oh, there is no pity at Juggernaut. Those who support his kingdom err, I trust from ignorance; they know not what they do."

"The loss of life," says Colonel Phipps, "by this superstition probably exceeds that of any other. The aged, the weak, the sick, are persuaded to attempt this pilgrimage, as a remedy for all evils. The number of women and children is also very great, and they leave their families and their occupations to travel immense distances with the delusive hope of obtaining eternal bliss. Their means of subsistence on the road are scanty, and their light clothing and little bodily strength are little calculated to encounter the inclemency of the weather. When they approach the temple they find scarcely enough left to pay the tax to government, and to satisfy the rapacious Brahmins; and, on leaving Juggernaut with a long journey before them, their means of support are often quite exhausted. The work of death then becomes rapid, and the route of the pilgrims may be traced by the bones left by the jackals and vultures, and the dead

bodies may be seen in every direction." It may be said, therefore, without any extravagance, that a certain portion of the British nation luxuriate upon the nicest dainties, and the choicest finery derived from the intolerable sufferings and the life's blood of the Hindoos! Do they? With regard to the number that perish on such occasions, Rev. Mr. Ward estimates that 4000 pilgrims perish every year on the route to and at holy places, an estimate which is considered by others as far below the truth. Captain F—— estimates those who died at Cuttack and Pooree, and between the two stations, at 5000. What a number of these deluded wretches must die before they reach their homes, many of them coming three, six, or nine hundred miles! Mr. M——, the European collector of the tax at Pooree, estimated the mortality at 20,000.

Juggernaut is the most celebrated station of idolatry in India. All the land within twenty miles is regarded as holy; but the most sacred spot is enclosed by a wall 21 feet high, forming a square of about 65 feet. Within this area there are about fifty temples, but the most conspicuous building consists of one lofty stone tower, 184 feet high and $28\frac{1}{2}$ feet square inside. The idol Juggernaut, his brother Bulbudra, and his sister Subadra occupy this tower. The roofs are ornamented with representations of monsters; the walls of the temple are covered with statues of stone, representing Hindoo gods with their wives in attitudes grossly indecent. The three idols alluded to are wooden busts six feet high, having a resemblance of the human head, and are painted white, yellow and black, with frightfully grim and distorted countenances. They are clothed with spangled broadcloth furnished from the export warehouse of the British Government. The car on which Juggernaut is drawn measures $43\frac{1}{2}$ feet high, has 16 wheels of $6\frac{1}{2}$ feet diameter, and a platform $34\frac{1}{2}$ feet square. The ceremonies connected with this idolatrous worship are in many cases exceedingly revolting and obscene. At Rani-but, in the Province of Gurwall, is a temple sacred to Rajah Ishwara, which is principally inhabited by dancing women. The initiation into this society is performed by anointing the head with oil taken from the lamp, placed before the altar, by which act they make a formal abjuration of their parents and kindred, devoting their future lives to prostitution; and the British Government by giving annually 512 rupees to the religious mendicants who frequent this temple, directly sanction this system of obscenity and pollution? Many temples of impurity exist in other places in Hindostan. Tavernier mentions a village in which there is a pagoda to which all the Indian courtesans come to make their offerings. This pagoda is decorated with a great number of naked images. Girls of eleven and twelve

years old, who have been bought and educated for the purpose, are sent by their mistresses to this pagoda to offer and surrender themselves to this idol. If, as we have seen, the French Government authorize prostitution at home, what do they more than the British Government does in India, only that they act a little more directly in the matter? Such an abominable practice is sure to bring its equivalent measure of punishment, sooner or later, upon the nation whose government allows or supports it.

In order to induce ignorant devotees to leave their homes, and commence pilgrimages to these scenes of impurity and idolatry a set of avaricious villains, termed pilgrim-hunters, are employed to traverse the country, and by all manner of falsehoods to proclaim the greatness of Juggernaut and their idols. They declare, for example, that the idol has now so fully convinced his conquerors (the British) of his divinity, that they have taken his temple under their own superintendency, and that they expend 60,000 rupees yearly to provide it with an attendance suitable to his dignity. These pilgrim-hunters *are paid by the British Government*. If one of them can march out 1,000 persons and persuade them to undertake the journey, he receives 1,500 rupees if they be of the lower class, and 3,000 rupees if they are persons belonging to the highest classes. And, what seems a very natural consequence, the procedure of the British Government in relation to this system has led many of the natives to suppose that the British people approve of the idolatrous worship established in India. A Hindoo enquired of a missionary: "If Juggernaut be nothing why does the company take so much money from those who come to see him?" Mr. Lacy, a missionary, who went to succour the destitute on the road to Cuttack, during one of the festivals, relates the following incident: "You would have felt your heart moved to hear, as I did, the natives say:—'Your preaching is a lie, for, if your Saviour and your religion are thus merciful, how do you then take away the money of the poor and suffer him to starve? It is indeed no wonder that when the natives see a poor creature lying, about to die for want, they should reflect that the two rupees he has paid as a tax would have supported his life.' Nor should it be a pleasing reflection to an English mind that these two rupees form precisely the difference between life and death to many who have perished for want on their way home." Another missionary relates: "Passing one evening a large temple I caught a sight at one of the idols and exclaimed, sinful, sinful!! The native who was with me asked: 'Sir, is that sinful for which the company gives thousands?' A man said to me a few days ago, 'If the government does not forsake Juggernaut, how can you expect that we should?'" In this way

the efforts of the Christian missionaries to convert the Hindoos are in many instances rendered of no avail. Could not the British nation endure to be less wealthy, and refrain from increasing their stock of riches by the support and encouragement of such a polluted system of idolatry, attended with such an amount of suffering, deprivation and death to the people of India? But, doubtless, the great body of the British people are ignorant of any such practice being authorized or countenanced by their government. Or, do the British Government carry on this vile business till now? People should prefer to live on herbs, and go clothed in the coarsest garments, rather than luxuriate on the most delicious fare, clothed in the finest and costliest garments, derived from such an unspeakably abominable and polluted source.

Another glaring instance of British moral or immoral character is found in their imposition by force of the drug opium upon the Chinese. We have stated before that opium is derived from the juice of the poppy plant, which is cultivated largely in India. We shall now state some facts in relation to this subject from the work of a late writer on China, a Christian missionary, who has lived among the Chinese for a number of years, and is fully conversant with this subject: * “The profits of the opium trade to Great Britain are enormous; not less than twenty to twenty-five millions of dollars a year. According to the estimate of an English newspaper, published in China, † the total profits from the time when the trade began until the year 1854 were, in round numbers, three hundred and ten millions of dollars, and from that time to the present it is three hundred and forty millions more. The total is about six hundred and fifty millions in sycee silver, that is, silver without alloy paid by weight. This is the actual net profit to the producer upon a trade which amounts to from sixty to eighty thousand chests a year, which are worth in all from forty to sixty millions of dollars. The extent of the responsibility of the British Government for the production and sale of opium I prefer,” says the writer, “to state in the words of one of its own subjects. The Calcutta correspondent of the *London Times* thus presents the case for the consideration of the readers of that influential paper: ‘What,’ says he, ‘are the facts? As to Bengal, I have gone through the poppy fields of Shahabad, and have witnessed every detail of the manipulation in the enormous go-downs of Patna. Under a severe contract law, twice as penal as any that has ever been proposed for ordinary agricultural purposes, and scouted

* “China and the United States,” by Wm. Speer, D.D., a missionary of the American Presbyterian Board.

† *The North China Herald* of Shanghai.

by England, advances of money are annually made to the peasants of Behar, Benares, and elsewhere.* The state lies out of these advances for a year. Its establishment of highly-paid officials, and oppressive or colluding native subordinates, supervises every detail, the preparation of the fields, the sowing, the weeding, the scraping of the capsules, the collection of the crude juice, its transit to the state factory, and its sale in Calcutta. Yet, in spite of its establishments, smuggling is the rule. The state of the case is this: China will have opium just as England will have gin, and Scotland whiskey. All facts go to show that the abuse of opium in China, though great, is by no means equal to that of alcohol in Europe. The moral question is, not whether China may be supplied with opium, but whether England as a nation, as the ruling power of India, ought, in its official and national character, to grow, manufacture, and export the drug, the use of which has, after two or three wars, been legalized in China. Yet this is the position of England at this moment in relation to three-fourths of the opium imported from India? What is the effect of the opium trade upon Christian missions? The writer and every man who has been engaged in the work of preaching the gospel, healing the sick, instructing the young, and disseminating the word of God, knows that the incessant and bitter objection urged by all classes to his efforts is that it is impossible that nations which carry opium in the right hand can carry any boon of mercy in the left. It (the opium traffic) is planting seeds of enervation, crime, and disease in the Chinese, who are coming to our shores, and creating corresponding vexation and injury to us; it keeps the sword of war continually unsheathed and wet with blood, the torch of conflagration constantly burning, and every puff of hostile wind distributing its sparks amidst materials which are ever ready to burn hotly; it makes the benevolent efforts of the preacher of the Gospel of mercy and of the Christian physician and teacher appear like shallow and abominable hypocrisy, and the word of God itself something false and hateful when offered by hands imbrued with so stupendous a crime against humanity and justice, against the conscience of man, and against the law of Heaven." Here we find a Christian nation itself the cause of the Gospel being virtually excluded from China, with its teeming population of four hundred millions of people. The same author says: "Would that it were possible to say that the hands of American merchants have not been stained by connivance

* It will be remembered that the opium is grown in British India, and is thence exported to China, and that the British Government has, by means of war, compelled the Chinese Government to admit it to their country, in which its sale is now legalized, as is well known by the latter to the great detriment of the Chinese people.

with the crime of the opium trade in China! We are grateful to God that it has not been made 'an official and national business to grow, manufacture and export the drug' by any other nation than Great Britain, and its Indian dependencies. But our ships have helped to convey and distribute the poison; our merchants have partaken to some extent of the profits of the work; and we have given it a garment of respectability by the deceitful pleas with which we have palliated its enormity." That unjust practice of forcing its commodities upon other nations against their will has of old been the policy of England. The reader may remember that the war which resulted in the independence of the United States, which until then were British colonies, arose from the British Government having undertaken to compel the colonists to receive its cargoes of tea against their will. In the case of the Americans they did not succeed in their undertaking, but in that of the Chinese they did after two or three wars, so that now the sale and use of the drug is legalized in that country. Great Britain, therefore, notwithstanding the progress she has made in the sciences and the arts, and the great efforts she has made in the dissemination of religious and other kind of knowledge, has yet much national injustice to answer for, and still far to advance before she has attained to true civilization, of which the practice of true Christian morality is the beginning and the ending: "Do unto others as you would have others do unto you."

Another unfavorable feature in the moral character of the British nation is the severity of its penal code. Among the variety of actions which men are daily liable to commit no less than 160 have been declared by Act of Parliament to be felonies without benefit of clergy, or in other words, to be worthy of instant death. Those who are found guilty of high treason are condemned by the law "to be hanged on a gallows for some minutes, then cut down while yet alive, the heart to be taken out and exposed to view, and the entrails burned." Though the most cruel part of this statute is said never to have been inflicted in modern times, yet its existence on the statute-book (does it now exist?) is a disgrace to the British nation, a disgrace which should be got rid of as quickly and as far as possible. Instead of diminishing the number of offenders experience teaches that crimes are almost uniformly increased by an undue severity of punishment. This was strikingly exemplified in the reign of Henry VIII., remarkable indeed for the number of its crimes, which certainly does not seem to have arisen from mildness of punishment. In that reign alone, says his historian, 72,000 executions took place *for robberies alone*; exclusive of the *religious murders*, which are known to have been so numerous as to amount, on

an average, to six executions a day, Sundays included, during the whole reign of that monarch.* The design of the institution of government is, or ought to be, to subserve the benefit of the governed, to advance their highest interests; but the government which will carry on such a wholesale slaughter among its people as that under the English monarchs did seems certainly to have another object in view, not for the benefit, but for the injury and destruction of its people.

If we enquire after the moral character of the United States as a nation, we shall find that it, too, has been affected with many of those imperfections which we have seen so glaringly to be in the case of those we have reviewed. By war it attained its existence as a nation, and by the exercise of war it has maintained its independence and integrity, as well as extended its dominions. By the war of the revolution, ending in 1776, the independence was achieved, and by that of 1812 it was maintained. The United States has also carried on a war with Mexico, as a result of which the territories of the former have been extended westward to the Rio Grande and over New Mexico, Arizona and California. The States have also carried on another great war with its own people, dark and fratricidal in its character, and which, though it may be thought to be productive of many good results, yet there are many reasons to deplore.

It appears that the wars which the first colonists carried on with the Indian tribes arose from their peculiar position in relation to those tribes; but there are reasons to believe that the Indians were taken advantage of in too many cases by the white settlers of the Atlantic States. In their advance inland they drove the Indians before them, and gradually exterminated them as they advanced. If it be enquired what has become of all the Indian tribes which once inhabited the Northern, the Southern, and the Western States to the Mississippi River; what has become of all the Indians that three centuries ago inhabited the Continent of America now thickly inhabited by white people? The answer is plain; they have in the main been exterminated by the whites, gradually, by means of war, and secretly. Many strange but likely stories are told by some of the old settlers around the Great Lakes of the ways in which they have known the Indians to be got rid of. And the means employed in one section of the country to get rid of them, or means equally effective, may also have been employed in other sections for the same purpose. Some of the Indians, doubtless, made their way into

* Hume: Reign of Henry VIII.

British America, still beyond the reach of the whites, and some of them are provided for by the United States Government in territories apportioned to them for a residence; but the greater part of the Indians must necessarily have suffered extermination by the whites in their gradual settlement of the country. Since the formation of the United States Government, however, the Indians that have submitted to it have been liberally dealt with, and a like liberal treatment has always been given by the British Government to the Indians settled within their North American possessions. And it may, perhaps, be considered that the Indians by their uncalled-for aggressions on the new comers, were, to a great extent, the cause of their own destruction. The two races might have lived together peaceably and prosperously if they had mutually cultivated and exercised toward each other the proper temper and spirit,—there was abundant room for all on the wide Continent of America,—but they were mutually jealous, it appears, and suspicious of each other; either did not feel themselves safe in the neighborhood of the other; and thus arose their mutual warfare. Heretofore, in the history of mankind we observe that when two races, speaking different languages, and differing from each other, perhaps, only triflingly in other respects, came face to face on the same soil, human barbarity has generally necessitated the yielding of the one to the other. Instead of the principle of benevolence, that of malevolence is usually practised in such cases. Cannot a new era, an era of benevolence, of self-denial, of humility and peaceful industry be inaugurated? It can, if each one living will do their part towards it by always cultivating and exercising the right temper and spirit.

The existence of slavery so long in the United States was the greatest moral reproach to the nation. The way, also, in which it was got rid of is a reproach. The pride and haughtiness of certain individuals of the rival parties—slave and free—kindled the flame of war, which for four years waged with such destructive violence. The result of the war—the abolition of slavery—was great, but how much better it would have been had the same result been accomplished by peaceful measures and means. Slavery is an evil, which every one must conscientiously know to be an evil, but because an evil exists must an equal evil be perpetrated in order to get rid of it? Should the proud hearts of the leaders of the South and North not bend to an act of legislation by which the slaves might be emancipated by means of an equitable purchase, and slavery abolished? The thing was not impracticable, for it had been done before by the British Government in the case of their West Indian slaves. Or, on the other hand, should not those who held the slaves in bondage

have acted benevolently toward them and set them free, and put them to work at a fair wages? It is time that such benevolence were exercised by human beings toward each other. It is said to be more blessed to give than to receive. Men have but a short time to live on this earthly scene, and though they be rich or poor, they will be all the happier and better for doing all the good that lies in their power, by acting benevolently and beneficently towards each other. There is no doubt of this. Let each one realize it for one's self. Your Creator is everywhere present, recognizes all your acts, and will be sure to reward the good acts, and, if you are unable to act, the good-will and intentions. You are also an accountable being, and will in yourself experience the consequences of your evil, whether of omission or of commission. A small moiety of the treasure which was expended in carrying on that atrocious war—the result of pride and selfishness in a few—might have been sufficient to have bought the slaves out at a fair price. And how many fathers, and husbands, and brothers, and sons, whom that war has laid low, would now be alive, a help and a comfort to their friends, and a blessing to their country! The emancipated negroes would be equally well off,—perhaps better,—the country much more prosperous, and the people much happier. America, both South and North, would thus have given proof of a higher state of civilization, and of a higher moral character, than it now can be admitted to have attained. How long before men come to realize that their duty is to deny self, to subdue and eradicate pride, and to act benevolently and charitably towards each other! May there not be less crime of a private and of a public nature committed in the United States? Will not each individual, old and young, male and female, in the republic, leave nothing undone which they can do to bring about the era of righteousness, and peace, when all shall enjoy and be satisfied with the fruits of their own integrity, industry and strictly moral living? The country which has hitherto been the refuge of the poor and oppressed of all nations may thus be rendered of still greater benefit to mankind.

Third, Illustrations from the nations called civilized especially in their religious aspect; First, from the history of the Catholic Church of the Roman Empire.

Heretofore in our review of the moral character of the civilized nations we have spoken of Rome and its empire with reference mainly to its civil aspect. Now we shall enquire what information history affords us as to the character and doings of the Catholic Church, whose head was the Pope. Hitherto we have not found that the

nations called civilized are exalted to a very great degree above those called uncivilized, in point of true morality (although they are exalted in some degree), so that our readers may ere this have begun to suppose that if the nations called civilized have much in their moral character to entitle them to the name civilized, it must be found in the religion they profess. We shall see.

The New Testament teaches us of the characters of the founders of the Christian Church. They are all said to have been men distinguished for self-denial, for humility, for charity, and for active industry in the cause which they espoused, and endeavored to promote. During the early ages of Christianity a goodly portion of the same spirit was manifested by the greater number of those who enrolled themselves as the followers of Christ. Even in the midst of the reproaches and persecutions to which they were subjected during the two first centuries of the Christian era, a meek and forgiving disposition, and a spirit of benevolence towards one another, and toward all mankind, distinguished them from the heathen around and constrained even their enemies to exclaim: "Behold how these Christians love one another!" But no sooner was the Church combined with the State in the days of Constantine than its native purity began to be sullied, and Pagan maxims and worldly ambition began to be blended with the pure doctrines of Christianity. Many of its professed adherents, overlooking the grand practical bearings of the Christian system, began to indulge in vain speculations concerning its doctrines which they could not understand; to substitute a number of unmeaning rites and ceremonies in the place of love to God and man, and even to persecute, and destroy all those who refused to submit to their opinions and decisions. Pride and ambition usurped the place of humility and meekness, and the foolish mummeries of monastic and ascetic superstition and austerity were substituted in the place of the active duties of justice and benevolence. Saints were deified; the power of the clergy was magnified; religious processions were appointed; pilgrimages were performed to the tombs of the martyrs; monasteries and nunneries without number were erected; prayers were offered up to the departed saints; the doctrine of the Trinity was instituted; the Virgin Mary was recognized as a species of inferior deity; the sign of the cross was regarded as capable of securing victory in all kinds of trials and calamities, and as the surest protection against the influence of malignant spirits; the bishops aspired after wealth, magnificence, and splendor, which they have not yet ceased to do; errors in religion were punished with civil penalties and bodily tortures; and the most violent disputes and contentions disturbed every section of the Catholic

Church; while the mild and beneficent virtues of the religion of Christ were either discarded or thrown into the shade. Of these and similar dispositions and practices we might give details which would fill many volumes, and which would convince every impartial mind that the true lustre of Christianity was sadly obscured, and its heavenly spirit almost extinguished, amidst the mass of superstitious observances, of vain speculations, and of angry feuds and contentions, which prevailed. Millot, in speaking of the state of the Church in the days of Constantine and the succeeding emperors, justly remarks: "The disciples of Christ were inspired with mutual feuds, still more implacable and destructive than the factions that were formed for or against different emperors. The spirit of contention condemned by St. Paul became almost universal. New sects sprung up incessantly and combatted each other. Each boasted its apostles, gave its sophisms for divine oracles, pretended to be the depositary of the faith, and used every effort to draw the multitude to its standard. The Church was filled with discord; bishops anathematized bishops; violence was called into the aid of argument, and the folly of princes fanned the flame which spread with such destructive rage. They played the theologists, attempted to command opinions, and punished those whom they could not convince. The laws against idolators were soon extended to heretics; but what one emperor prescribed as heretical was to another sound doctrine. What was the consequence? The clergy, whose influence was already great at court, and still greater among the people, began to withdraw from the sovereign authority that respect which religion inspires. The popular ferments being heightened by the animosities of the clergy, prince, country, law or duty were no longer regarded. Men were Arians, Donatists, Priscillianists, Nestorians, Eutychians, Monothelites, etc., but no longer citizens, or, rather, every man became the mortal enemy of those citizens whose opinions he condemned. This unheard-of madness for irreconcilable quarrels or subjects which ought to have been referred to the judgment of the church, never abated amid the most dreadful disasters. Every sect formed a different party in the State, and their mutual animosities conspired to sap its foundations."*

At the period to which these observations refer, two erroneous maxims appear to have generally prevailed, which tended to undermine the gospel system of morality, and which were productive of almost all the contentions, tumults, and massacres, which distinguish that era of the Christian Church. These were, first, that religion con-

* Millot's Modern Hist., Vol. 1.

sisted in the belief of certain abstract and incomprehensible dogmas, and in the performance of a multitude of external rites and ceremonies; and, second, that all heresies or differences of opinion on religious points ought to be extirpated by the arm of the civil power. Than such maxims nothing can be more repugnant to reason or subversive of genuine morality, or more inconsistent with the genius and spirit of the true religion of Christ. And yet, to this time, they are acted upon by four-fifths of the Christian world, notwithstanding the numerous examples which history furnishes of their futility and erroneous tendency. We shall state only two or three instances referring to this period. The Emperor Theodosius came to the throne of the Roman empire in the year 379, A.D. Being originally a pagan he was baptized into the Christian church in the second year of his reign, during a severe illness, which threatened his life, and on his recovery he professed great zeal for that church. Soon after his baptism, he dictated the following edict: "It is our pleasure that all the nations which are governed by our clemency and moderation should steadily adhere to the religion which was taught by St. Peter to the Romans, which faithful tradition has preserved, and which is now professed by the Pontiff Damasus, and by Peter, bishop of Alexandria, a man of apostolic holiness. According to the teaching of the apostles, and the doctrines of the Gospel let us believe the sole deity of the Father, the Son, and the Holy Spirit, under an equal majesty and a pious Trinity. We authorize the followers of this doctrine to assume the name of Catholic Christians; and as we judge that all others are extravagant madmen, we brand them with the infamous name of heretics, and declare that their conventicles shall not longer usurp the respectable name of churches.—Beside the condemnations of divine justice they must expect to suffer the extreme penalties which our authority, guided by heavenly wisdom, shall think proper to inflict upon them." *

Theodosius declared apostates and Manicheans incapable of making a will or receiving any legacy; and, having pronounced them worthy of death, the people thought they had a right to kill them as proscribed persons. He enacted a law condemning to the flames cousins-german, who married without a special license from the emperor. He appointed inquisitions for the discovering of heretics. He drove the Manicheans from Rome as infamous persons, and on their death ordered their goods to be distributed among the people. In the space of ten years, he promulgated at least fifteen severe edicts against nonconformists and heretics, more especially those who re-

* Gibbon's Rome.

jected the doctrine of the Trinity which, under his reign, was established by law ; and to deprive them of every hope of escape he sternly enacted that if any laws or rescripts should be alleged in their favor, the judges should consider them as the illegal productions either of fraud or forgery. Leo, another emperor, “ commanded every person to be baptized under pain of banishment, and made it a capital offence for any one to relapse into idolatry after the performance of that ceremony ;” as if men could be made Christians by a forced baptism or by a law of the state. Such edicts clearly showed that whatever zeal those princes or the clergy might manifest in favor of the Christian religion, they were totally devoid of the true spirit, and ignorant of the means by which its benevolent objects were to be accomplished.

To illustrate the manner in which such edicts were carried into effect, the following instance may be stated : Hypatia, the daughter of Theon, the celebrated geometrician of Alexandria, exceeded her father in learning, and gave public lectures in philosophy with the greatest success ; nor was she less admirable for the purity of her virtues, joined to an uncommon beauty, and every accomplishment that could adorn human nature. But that excellent woman, because she would not accept of the established religion, and was supposed to be active against St. Cyril, the bishop, became an object of detestation to the Christian multitude. A set of monks and desperadoes, headed by a priest, seized her in the open street, hurried her into a church, where they stripped her naked, lacerated her body with whips, cut her in pieces, and publicly burned her mangled limbs in the market place.* St. Cyril, who was suspected of having fomented this tragedy, had previously attacked the synagogues, and driven out the Jews ; their goods were pillaged, and several persons perished in the tumult. Such conduct plainly demonstrates the tendency of the human mind to abuse power, for the purpose of revenge and persecution ; and illustrates, also, what the ideas of these persecutors were of their pretended religion.

About this time, and afterwards also, vain speculations about abstruse and incomprehensible subjects occupied the mind and the time of theologists, engendered religious quarrels and disputes, and burst asunder the bonds of affection and concord. A play upon words and vain subtleties were substituted for clear conceptions and substantial knowledge ; which instead of directing the faculties of the human mind to the proper objects, tended to obscure the light of reason, and to usher in the long night of ignorance, characterized

* Millott's Modern History.

as the Dark Ages. It was a prevailing madness with these early theologists, who were obstinately tenacious of their opinions, and it has been too much the case with certain modern theologists to dispute about doctrines which they claimed to be incomprehensible, to render them more obscure by their attempts to explain them, never giving the proper explanation, and perpetually to revive the most angry contentions.

The Arians rejected the divinity of Christ in order to maintain the unity of God; the Nestorians denied that Mary is the mother of God, and gave two persons to Jesus Christ to support the opinion of His having two natures. The Eutychians, in order to maintain the unity of the person, confounded the two natures in one. This sect became divided into ten or twelve branches, many of them, as the Gnostics of the Primitive Church, maintaining that Christ was merely a phantom or appearance of flesh, but not real flesh. The Monothelites maintained that Christ had only one will, as they could not conceive two free wills to exist in the same person. Another sect maintained that Christ's body was incorruptible, and that from the moment of His conception He was incapable of change and of suffering. This chimera the Emperor Justinian attempted to establish by an edict. He banished the patriarch Eutychius, and several other prelates who opposed his sentiments, and was preparing to tyrannize over the conscience of men with still more violence, when, after a long reign, death interposed, and removed him from this earthly scene.

In such vain and preposterous disputes as these the minds of professed Christians were occupied, notwithstanding the perils with which they were then encompassed by the invasion of the barbarians. Councils were held to determine the orthodox side of a question; anathemas were hurled against those who refused to acquiesce in their decisions; princes interposed their authority, and the civil power stood ready to compel men to profess what they did not believe and could not understand, while the essential truths of religion were overlooked, and its morality disregarded. "Religion," says Millot, "inspires men with a contempt of earthly vanities, a detestation of vice, and indulgence for the frailties of our neighbors, invulnerable patience in misfortune and compassion for the unhappy; it inspires us with charity and heroic courage, and tends to sanctify every action in common and social life. How sublime and comforting the idea it gives of the Divinity; what confidence in His justice and infinite mercy; what encouragement for the exercise of every virtue; wherefore, then, such errors and excesses on religious pretences? It is because heresy, starting up under a thousand different

forms, incessantly startles the faith by subtleties and sophistry, by which almost the whole energy of men's minds is absorbed in the contest. Disputes engender hatred; from hatred springs every excess; and virtue, exhausted with words and cabals, loses her whole power." How well it would be for the cause of genuine Christianity, and how promotive of the happiness of mankind, if the present and future generations would profit by the experience of the past!

As we advance in the history of the Christian Church through the Middle Ages the prospect becomes still more dark and gloomy: the human mind at that period appears to have lost its wonted energy and power of determination; the light of reason seemed well-nigh extinguished; sophisms and absurdities of all kinds were swallowed and left undigested, and superstition displayed itself in a thousand different forms; morality was smothered up under a heap of ceremonies, and arbitrary observances obtained the name of devotion; relics, offerings, pilgrimages, and pious legacies were thought capable of opening the gate of heaven to the most wicked of men; the Virgin Mary and the souls of departed saints were invoked; splendid temples and shrines were erected to their honor, and their assistance was entreated with many fervent prayers; an irresistible efficacy was attributed to the bones of martyrs, and to the figure of the cross, in defeating the temptations of Satan, in warding off all sorts of calamities, and in healing the diseases of the body and of the mind; works of piety and benevolence, as in Romish countries at the present day, were viewed as consisting chiefly in building and embellishing churches and chapels, in endowing monasteries, in hunting after the relics of martyrs, in procuring the intercession of saints by rich oblations, in worshipping images, in pilgrimages to holy places, in voluntary acts of mortification, in solitary masses, and in a variety of similar services which could easily be reconciled with the commission of the most abominable crimes; so that the worship of the invisible Deity, the Creator of all, was exchanged for the worship of hair, bones, fragments of fingers and toes, tattered rags, images of saints, and bits of rotten wood, supposed to be the relics of the cross; the canonizing of saints became the fruitful source of frauds and abuses throughout the Christian world; lying wonders were invented, and fabulous histories and legends composed to celebrate exploits that were never performed, and to glorify persons that never had a being; and absolution from the greatest crime could be easily obtained either by money or by penance. During the eighth and ninth centuries, there were perpetual contests as to images, whether or not they should be worshipped; one emperor permitted, another prohibited, their worship. An emperor, in the beginning of his reign, as Leo

the Isaurian, bows down in abject homage to them, and thereby secures the favor of the Pope and his prelates; in the latter part of his reign he breaks them to pieces, and thereby obtains their displeasure and active opposition. Hence arose the term Iconoclasts, or image-breakers, in contradistinction to image-worshippers. The sect of the Iconoclasts was supported by six Emperors, and the whole Catholic church was involved in a noisy conflict between these two opposing parties for a period of one hundred and twenty years.

The absurd principle that religion consists of acts of austerity produced the most extravagant behavior in certain devotees and reputed saints. They lived among the wild beasts; they ran naked through the lonely desert, with a furious aspect, and with all the perturbations of madness and frenzy; they prolonged their wretched lives by grass and wild herbs; avoided the sight and conversation of men, and remained almost motionless for several years exposed to the rigor and inclemency of the seasons; and all this was considered as an acceptable method of worshipping the Deity, and of obtaining His favor.

But of all the instances of superstitious frenzy which disgraced those times none was held in higher veneration than that of a certain order of men called Pillar Saints. These were persons of a most singular and extravagant turn of mind, who stood motionless on the top of pillars, expressly raised for this exercise of their patience, and remained there for several years the objects of the admiration and applause of a stupid and wondering populace. This strange superstitious practice began in the sixth century, and continued in the east for more than six hundred years. The name and genius of Simeon Stylytes have been immortalized by the invention of this aerial penance. At the age of thirteen years, the young Syrian deserted the profession of a shepherd, and threw himself into a monastery. After a long and painful novitiate, in which he was repeatedly saved from pious suicide, Simeon established his residence on a mountain, about thirty or forty miles to the east of Antioch. Within the space of a Mandra, or circle of stones, to which he had attached himself by a ponderous chain, he ascended a column, which was successively raised from the height of nine to that of sixty feet from the ground. In this last and lofty station the Syrian monk resisted the heat of thirty summers, and the cold of as many winters. Habit and exercise instructed him to maintain his dangerous situation without fear or giddiness, and successfully to assume the different postures of devotion. He sometimes prayed in an erect attitude with his arms outstretched in the figure of a cross, but his most familiar practice was that of bending his meagre skeleton from the

forehead to the feet; and a curious spectator, after numbering 1244 repetitions of this act, at length desisted from the endless account. The progress of an ulcer in his leg might shorten, but it could not disturb this celestial life; and the patient monk expired without descending from his column. This voluntary martyrdom must have gradually destroyed the sensibility both of the mind and body; nor can it be presumed that fanatics who unnecessarily torment themselves are susceptible of any lively sympathy for the rest of mankind. A cruel, unfeeling temper has distinguished the monks of every age and country; their stern indifference is inflamed by religious hatred, and their merciless zeal has strenuously administered the office of the Inquisition.

To the same irrational principles are to be attributed the revolting practices of the Flagellants, a sect of fanatics who chastised themselves with whips in public places. Numbers of persons of this description of all ages and sexes made processions, walking two by two, with their shoulders bare which they whipped until the blood ran down in streamlets, in order to obtain the mercy of God and appease His anger against their wickedness. They held, among other things, that flagellation was of equal virtue with baptism and the other sacraments; that the pardon of all sins would be obtained by it, without the merits of Jesus Christ; that the old law of Christ was soon to be abolished, and that a new law, enjoining a baptism of blood to be administered by whipping, would be substituted in its place. The enormous power that came to be vested in the ecclesiastical rulers was another source of immorality, and of the greatest excesses. The Pope and the clergy reigned over the greatest part of the Catholic church without control, and made themselves masters of almost all the wealth in every country in Europe. Many of them perpetrated crimes of the deepest dye, and the laity, thinking themselves able to purchase the pardon of their sins for money, followed without scruple the example of their pastors. Every Christian country swarmed with lazy monks, and the most violent contentions, animosities and hatred reigned among their different orders, as well as between all ranks and orders of the clergy. "Instead of consecrating ecclesiastical censures solely to spiritual purposes, they converted them into a weapon for defending their privileges, and supporting their pretensions. The priesthood, which was principally designed to bless, was most frequently employed in cursing. Excommunication was made the instrument of damning instead of saving souls, and was inflicted according to the dictates of policy or revenge." The great and powerful, even kings and emperors, were excommunicated when it was designed to rob or to enslave them;

and this invisible engine, which they wielded with an effective and a sovereign hand, was used to stir up dissensions among the nearest relations, and to kindle the most bloody wars. The generality of priests and monks kept wives and concubines without shame or scruple, and even the papal throne was at some times the seat of debauchery and vice. The possessions of the church were either sold to the highest bidder or turned into a patronage for the bastards of the incumbents. Marriage, wills, contracts, the interests of families and courts, the state of the living and the dead were all converted into instruments for promoting their credit and increasing their wealth. It was, therefore, a necessary consequence of such a state of things that vices of every description abounded, that bad morals prevailed, and the benevolence of the divine law was trampled under foot.

The ignorance and superstition which the corruptions of Christianity introduced were dexterously improved by the ecclesiastical rulers to enrich themselves, and drain the purses of the deluded masses. Each rank and order of the clergy had its peculiar method of fleecing the people and increasing its revenues. "The bishops," says Mosheim, "when they wanted money for their private pleasures, granted to their flock the power of purchasing the remission of the penalties imposed upon transgressors by a sum of money, which was to be applied to certain religious purposes, or, in other words, they published indulgences, which became an inexhaustible source of opulence to the episcopal orders, and enabled them to form and execute the most difficult schemes for the enlargement of their authority, and to erect a multitude of sacred edifices, which augmented the external pomp and splendor of the Church. The abbots and monks, equally covetous and ambitious, had recourse to other methods for enriching their convents. They carried about the country carcasses and relics of the saints in solemn procession, and permitted the multitudes to behold, touch, and embrace those sacred and lucrative remains, at certain fixed prices. By this raree-show, the monastic orders often gained as much as the bishops did by their indulgences."* The Pope at length assumed the chief power over this profitable traffic, and "when the wants of the church, or the demon of avarice prompted them to look out for new subsidies, published not only a universal but a plenary remission of all the temporal pains and penalties which the Church had annexed to certain transgressions. They even audaciously usurped the authority which belongs to God alone, and impiously pretended to abolish even the punish-

* Mosheim's Hist., 12th Cent.

ments which are reserved in a future state for the workers of iniquity, a step which the bishops, with all their avarice and presumption, had never once ventured to take.”*

By the sale of such indulgences the money was obtained by means of which the magnificent structure of St. Peter's Church at Rome was built. Pope Leo X. published a system of indulgences, suited to all ranks and characters of men, and offered a plenary remission to all who would contribute their money to the furtherance of this and other projects he had in view; so that the foundations of this edifice, which has been so much admired, were laid, and its superstructure reared by the most diabolical and impious means, by the exercise of perfidy and insatiable avarice, and by the usurpation of the prerogatives of the Deity. This daring impiety was carried to such a pitch that indulgences were farmed out to the highest bidders, who, to make the most out of their bargain, procured the ablest declaimers, and the most eloquent preachers, to extol the efficacy, and enhance the value of such wares. A graduated scale of prices was arranged for the remission of sins of every description, not even excepting the most horrid crimes, such as the murder of a father, mother, or wife; so that for ninety livres, or a few ducats, or a less sum, a pardon might be procured from the “Apostolic Chancery,” for crimes which all civilized nations determined to be worthy of death. All the provinces of Europe were in a manner drained to enrich those ghostly tyrants, who were perpetually gaping after new accessions of wealth, in order to augment the numbers of their friends, and the stability of their dominions; and every stratagem was used to rob the subject without shocking the sovereign, and to levy taxes under the specious mask of religion.

Such was the shameless rapacity which then prevailed, that even in that age of ignorance and servility, the eyes of the people began to open, and to perceive the vileness, impiety, and false pretensions of the ecclesiastical orders. Not alone private persons, but princes and sovereign states began to exclaim loudly against the despotic dominion of the Popes, the fraud, avarice, and injustice that prevailed in their councils, the arrogance and extortion of the legates, and the unbridled rapacity and licentiousness of the clergy and monks, until at length the Protestant reformers, with the double object, doubtless, of strengthening their own cause and weakening that of their opponents, brought to light such a scene of extortion and profligacy as had never before been exhibited with such effrontery in any country under heaven.

* Mosheim's Hist., 12th Cent.

The public worship of the Deity was at that time little more than a pompous round of ceremonies, adapted rather to dazzle the eye of sense than to enlighten the understanding, or affect the heart. The sermons of the clergy were little else than fictitious reports of miracles, and prodigies, insipid fables, wretched quibbles and senseless jargon, which deceived the multitude instead of instructing them. The authority of the holy Mother Church, the obligation of obedience to her decisions, the merits and virtues of the saints, the dignity and glory of the Blessed Virgin, the efficacy of relics, the adorning of churches, the endowing of monasteries, the utility of indulgences, and the burnings of purgatory, were the principal subjects on which the clergy descanted, and which employed the pens of eminent doctors of divinity, because they availed to fill the coffers of the Mother Church, to augment her magnificence, and to advance her temporal interests as represented in the Papacy.

A certain class of persons connected with the Romish Church, designated by the title of the "Pope's Nephews," have always distinguished themselves by their arrogance and rapacity. An Italian writer of the 17th century, who appears to have been a moderate Catholic, when sketching the characters of the existing cardinals, and the Pope's Nephews, relates, among other curious and melancholy pieces of history, the following circumstances: "A friend of mine had the curiosity to calculate the money that had been given to the Nephews, and he began at the year 1500, and, after a great deal of pains he found issuing from the treasury of the Church, about seventy millions of double ducats,* all delivered into the hands of their kindred. And this is to be understood of visible moneys; for of private and invisible sums there may perhaps be twenty millions more. And those Romans that are within the town, and have more time to cast up what has been extorted from them, if they would take the pains to examine it more strictly, I am satisfied, would find it much more." The author, like a zealous Catholic, makes the following reflection on this fact: "If these seventy millions of double ducats had been spent in persecuting heretics, or in making war upon infidels, where would any infidel be? These seventy millions would have been enough to have overrun all Asia, and (which is of importance too), the princes would have contributed as much more had they seen the Popes more tenacious against their kindred, and more free to the soldiers who were fighting for Christ."

The same author states that "Innocent X., to satisfy the fancy of a kinswoman, spent a hundred thousand crowns upon a fountain, yet

* A double ducat is about \$2.50 in silver, or about \$5.00 in gold.

with great difficulty could scarce find forty thousand to supply the emperor in his war with the Protestants ;” and “this good Pope would nevertheless leave to his cousin, to the house of Pamphylia, and other houses allied to that, about eight millions of crowns, with which sum they flourish in Rome to this very day.” Again: “The Barbarini were in Rome at the same time, and enjoyed a rent of four hundred thousand crowns, and yet in a war of so much importance to the Catholic religion they could not find forty thousand. But, Oh, God! (I speak it with tears in my eyes) against the most Catholic princes of Italy whole millions were nothing; they could turn the cross into the sword to revenge their particular injuries; but, in the relief of the emperor who was vindicating the Christian faith, they could not find as much as a few hundreds.” “The infidels laugh, and the heretics rejoice to see the wealth of the Church so irreligiously devoured, while the poor Christian weeps at their merriment.” “The heat and passion which the Popes show hourly for their Nephews to gain principalities for them, to bestow pension upon pension upon them, to build palace upon palace for them, and to fill their coffers with treasures to the brim is that which cools the resolution of the zealous prince, and exasperates the infidels in their wicked designs. A great shame it is indeed that the heretics should have more ground to accuse the Catholics than the Catholic has to impeach the heretic.” And he adds the following apostrophe in reference to this subject: “Oh God! to what purpose will they keep so many jewels at Loretta, so much consecrated plate at Rome, so many abbeys for their Nephews, so much wealth for the Popes, if, abandoning their Commonwealth, and refusing it that humane supply that is necessary for the celestial glory, it be constrained to submit to the Ottoman power, which is threatening it now with the greatest effect? If the wealth of the Popes be devoured, the benefices of the cardinals given to the priests of Mahomet, the abbeys of the Nephews usurped by the Turks, the sacred vessels of Rome profaned by these infidels, and the seraglio adorned with the gems of the Loretta, God grant my eyes may never see that spectacle!” *

Thus, it appears, from the testimony of Catholic writers, that the immense sums which were wrested from the people by every species of fraud and extortion, instead of being applied to the maintenance and defence of the Church, as was pretended (which application, in the state in which the Church was then, would not have been an over-good one either), were wasted in luxury and extravagance by the Popes and their minions in selfish gratifications, in riot and

* See a volume in Italian entitled “*Il Cardinalismo di Sancta Chiesa.*” Or the History of the Cardinals of the Roman Catholic Church.

debauchery, in accumulating wealth on the heads of their relatives and favorites, most of whom were infidels and debauchees, in gratifying the pride and avarice of courtesans, and in the most romantic and ambitious projects. The single structure of St. Peter's, at Rome, is said to have cost the enormous sum of sixty millions of dollars, and in our age and country would have cost, at least, three times that amount. What immense sums, then, must have been expended on similar objects intended merely for worldly ostentation by the Catholic hierarchy throughout the whole of christendom, besides the millions that were expended in their pursuits of tyranny, sensuality and debauchery. The mind, when it reflects upon it, is almost overwhelmed at the thought that such sacrilegious enormities should have been so long continued with impunity, and that such immense treasures should have been consecrated for so many ages to the support of the kingdom of darkness, while the true Christian church was allowed to pine away in poverty, and compelled to hide its head in dens and caves of the earth.

The Pope's revenues as a temporal prince, at the beginning of this century, have been calculated to amount to at least a million of pounds sterling, or five millions of dollars a year, arising chiefly from the monopoly of corn, the duties on wine and other products. Over and above these, vast sums were continually flowing into the papal treasury from all the Roman Catholic countries for dispensations, indulgencies, canonizations, annats, the pallia, the investitures of bishops archbishops, and other resources. It is computed that the monks and regular clergy who were absolutely at the Pope's devotion did not amount to less than two millions of persons, dispersed through all the Roman Catholic countries, to assert his supremacy over princes, and to promote the interest of the Church. The revenues of these monks and priests did not fall short of two hundred millions of pounds sterling, or a thousand millions of dollars, besides the casual profits arising from offerings and the people's bounty to the Church, who are taught that their salvation depends upon this kind of charity. In Spain alone the number of ecclesiastics, including the parochial clergy, monks, nuns, syndics, inquisitors, etc., amounted to 188,625. The number of archbishops was eight, and of bishops forty-six. The archbishop of Toledo alone had a revenue, which, according to the most moderate computation, amounted to four hundred and fifty thousand dollars a year. In Portugal, in 1732, there were reckoned above 300,000 ecclesiastics out of a population of less than two millions. The patriarch of Lisbon had an annual revenue of one hundred and fifty thousand dollars, and the revenue of the patriarchal church above \$570,000. It is stated by Mr. Locke in the diary of

his travels that the expense of the ecclesiastical establishment in France, at the time that he resided in that country, amounted to about twenty-four millions of pounds sterling, or one hundred and twenty millions of dollars. This may give some idea of what must have been the immense treasures of wealth collected by the Roman Popes and bishops, prior to the Reformation, when the whole of the European nations were in subjection to them, and when the newly discovered countries in the Western World were plundered to augment their revenues and to satiate their rapacity!

The theological speculations in which these ecclesiastics indulged corresponded to their degrading practices, and tended to withdraw the mind from the substantial realities both of science and virtue; sophisms and falsehoods were held forth as demonstrations. They attempted to argue after they had lost the rules of common sense. The cultivation of letters, as well as of the arts, was neglected; eloquence consisted in futile declamations; and true philosophy was lost in the abyss of scholastic and sophistical theology. They endeavored to render theology a subject of metaphysical speculation, and of endless controversy. A false logic was introduced which subtilized upon *words*, but gave no idea of *things*, which employed itself in nice and refined distinctions concerning objects and operations, which lay beyond their limited understandings, and which *could not* be understood. The following are only a few instances out of many that might be brought forward of the questions and controversies which occupied the attention of bishops and scholarly doctors, and gave rise to furious contentions: Whether the conception of the Blessed Virgin was immaculate? Whether Mary should be denominated the mother of God or the mother of Christ? Whether the bread and wine used in the Eucharist were digested? In what manner the will of Christ operated; and whether He had one will or two? Whether the Holy Spirit proceeded from the Father and the Son or only from the Father? Whether leavened or unleavened bread ought to be used in the Eucharist? Whether souls in their intermediate state see God or only the human nature of Christ? It was disputed between the Dominicans and Franciscans whether Christ had any property. The Pope pronounced the negative proposition to be a pestilential and blasphemous doctrine, subversive to the Catholic faith. Many councils were held at Constantinople to determine what sort of light it was which the disciples saw at Mount Tabor. It was solemnly pronounced to be the eternal light with which God is encircled, and which may be termed his energy or operation, but is distinct from his nature or essence. The disputes respecting the presence of Christ in the Eucharist led to this absurd

conclusion, which came to be universally admitted: "that the substance of the bread and wine used in that ordinance is changed into the real body and blood of Christ," and consequently when a man eats what has the appearance of a wafer, or a piece of bread he really and truly eats the body and blood and soul of Christ; and when he afterwards drinks what has the appearance of wine, he drinks the very same body and blood, and soul, which, perhaps not a minute before he had wholly and entirely eaten!

At the period to which we now allude the authenticity of a suspected relic was proved by bulls. Councils assembled and decided upon the authority of forged acts with regard to the antiquity of a Saint, or the place where his body was deposited; and a bold impostor needed but to open his mouth to persuade the multitude to believe whatever he pleased. To feed upon animals strangled or unclean, to eat flesh on Tuesday, eggs and cheese on Friday, to fast on Saturday, or to use unleavened bread in the service of the mass, were by some considered as indispensable duties, and by others as vile abominations. In short the history of the period is a reproach to the human understanding, an insult offered to reason, and a libel on the benevolent spirit which breathes through the true religion of Christ.

Nothing can be more directly opposed to the spirit which this religion inculcates, than the temper and conduct of many, if not all, of those who arrogated to themselves the character of being "God's vicegerents on earth," and who assumed to themselves the sole direction and control of the Christian church. In persons who laid claim to functions so sacred and divine it might have been expected that, at least, the appearance of piety, humility and benevolence would have been exhibited before the Christian world. But the history of the Popes and their satellites displays almost everything which is directly opposed to such heavenly virtues. Their avarice, extortion, and licentiousness became intolerable and excessive, even to a proverb. To extend their power over the kingdoms of the earth, to increase their wealth and revenues, to live in opulence and splendor, to humble earthly rulers, to alienate the affections of their subjects, and to riot in the lap of luxury, sensuality, and debauchery, seemed to be the great objects of their ambition. Instead of acting as the heralds of mercy, and the ministers of peace, they thundered anathemas against all who dared to call in question their authority; kindled the flames of discord and civil wars, armed subjects against their rulers, led forth hostile armies to battle, and filled Europe with confusion, devastation and carnage. Instead of applying the mild precepts of Christianity and interposing their authority for reconciling

enemies, and subduing the jealousies of rival monarchs, they on many occasions delighted to widen the breach of friendship and to fan the flame of animosity and discord. Dr. Robertson, when adverting to the personal jealousies of Francis I. and Charles V., remarks: "If it had been in the power of the Pope to engage them in hostilities, without rendering Lombardy the theatre of war, nothing would have been more agreeable to him than to see them waste each other's strength in endless quarrels.*"

Some of our readers may have ere this become impatient and disgusted with the characters which have been drawn of ghostly leaders of the people. They may, however, remember that these are but a few of the facts of a similar kind which history presents before us, and that they are not exaggerated. The Son of Man comes into the world not to destroy men's lives but to save them; but in such instances we behold his pretended vicars preparing and arranging the elements of discord, laying a train for the destruction of thousands, and tens of thousands, and taking a diabolical delight in contemplating the feuds, the massacres, and the miseries, which their infernal policy had created. The decrees from the papal throne, instead of breathing the mildness and benevolence of the gospel, became thundering curses and sanguinary laws, and a set of fanatic enthusiasts or a lawless banditti were frequently appointed to carry them into effect. Not resting satisfied with the insurrections and the desolations they had caused among the European nations, they planned an expedition for the purpose of subduing Western Asia, and consequently of massacring its inhabitants. Urban II., about A.D. 1095, travelled from province to province levying troops, even without the consent of their princes, preaching the doctrine of "destruction to the infidels," and commanding the people in the name of God to join in the *holy war*. Peter the Hermit, represented by historians as a man of hideous figure and aspect, covered with rags, walking barefooted and speaking as a prophet, inspired the people everywhere with an enthusiasm similar to his own. St. Bernard ran from town to town haranguing the populace, performing pretended miracles, and inducing all ranks, from the emperor to the peasant, to enroll themselves under the banner of the cross. Thousands of wicked and abandoned debauchees were thus collected; and bishops, priests, monks, women and children were all enrolled in the *holy army*. A plenary absolution of all their sins was promised, and if they died in the contest they were assured of a crown of martyrdom in the world to come. With hearts burning with fury and revenge this army of banditti, without discipline,

* Robertson's Charles V. Book II.

or sufficiency of provisions, marched in wild confusion through the Eastern parts of Europe, and at every step of their progress committed the most horrible outrages. So inveterate was their hatred of the Jews wherever they found them, that many of these unfortunate beings, both men and women, murdered their own children in the midst of the despair to which they had been driven by those infuriated madmen; and when they had arrived at Jerusalem, and had taken the city by assault, they made a universal slaughter of the infidels. Such was the way in which the successors of the apostles and the vicars of Christ displayed their general benevolence, and their love for the souls and bodies of men.

The establishment of the Inquisition is another mode in which the tyranny and cruelty of the Church of Rome have been displayed. The office of inquisitors of the faith was first instituted under Theodosius, and was, doubtless, retained and exercised to a greater or less extent in all the ages subsequent to him. But the Court of the Inquisition, which became so terribly notorious, was founded in the Twelfth Century, by Father Dominic and his followers, who were sent by Pope Innocent III., in order to excite the Catholic princes to extirpate heresy, and was, some time after, put into execution in Spain with awful effect. It is scarcely possible to conceive of any institution more diametrically opposed to the dictates of justice and humanity, and to the genius of the religion of the Gospel, than is this infernal tribunal. The proceedings against the unhappy victims of that court were conducted with the greatest secrecy. The person granted them as counsel was not permitted to converse with them, except in the presence of the inquisitors; and when they communicated the evidence to the accused persons they carefully concealed from them the name of the authors. The prisoners were confined for a long time until they themselves, by the application of the torture, became their own accusers; for they were neither told their crime nor confronted with witnesses. When there was no shadow of proof against the accused person, he was discharged after suffering the most cruel tortures, a tedious and dreadful imprisonment, and the loss of the greatest part of his effects. When he was convicted and condemned, he was led in procession with other unfortunate victims on the festival of the "*Auto da fé*" (Act of Faith), to the place of execution. He was there clothed with a garment painted with flames, and with his own figure surrounded with those of dogs, serpents, and devils, all open-mouthed, as if ready to devour him. Let the reader for a moment imagine himself in this situation, at the mercy of these fiendish men, simply because he could not conscientiously confess his belief of their absurd doctrines; he will thus the better realize

the position of these victims. Such of the prisoners as declared that they died in communion with the Church of Rome were first strangled, and then burned to ashes. Those who died in any other faith were burned alive. The priests told them that they left them to the devil, who was standing at their elbow to receive their souls, and carry them with him into the flames of hell; as if there could possibly be any more real devil than these priests themselves, or any more real flames than those to which they subjected their victims. Flaming furzes fastened to long poles were then thrust against their faces, until their faces were burned to a coal, which was said to be accomplished with the loudest acclamations of joy among the thousands of spectators. At last, fire was set to the furze at the bottom of the stake over which the criminals were chained so high, that the top of the flame seldom reached higher than the seat they sat on; so that they were roasted rather than burned. There could not be a more lamentable spectacle; the sufferers continually crying out while they were able: "Pity for the love of God," etc.; yet it is said to have been beheld by people of all sexes and ages, with transports of joy and satisfaction; and even the monarch, surrounded with his courtiers, has sometimes graced the scene with his presence, imagining in his wicked ignorance that he was performing an act highly acceptable to God.* And yet there are amongst us Protestants, calling themselves "High Churchmen" and what not else, who are of the inquisitorial order except in name. How long before the cause of truth and humanity is asserted? How long before the preachers of deceit and falsehood are left to preach to the walls or to the winds? And what were the crimes for which those dreadful inquisitorial punishments were inflicted? Perhaps nothing more than reading a book which had been condemned as heretical by the holy office; assuming the title of freemason; irritating a priest, or mendicant friar; uttering the language of a free thinker; declaiming against the celibacy of the clergy; insinuating hints or suspicions respecting their amours or debaucheries; or throwing out a joke to the dishonor of the Virgin Mary, or, at most, holding the sentiments of a Mahometan, or a Jew, or of the followers of Luther or Calvin.

The particular statements of facts as to the doings of the Inquisition during the series of centuries of its judicature and operation I reserve for their proper place in volume 2 of this work, under the head of "The Papal-Germanic Church and State System." As there, these facts will show what an ineffably bad being man is capable of becoming by his developing in his life and character, especially in his dealings toward his fellow-men, the spirit and character of the evil one. These facts would certainly appear to be sufficient to remove incredulity from the mind of a good man as to what may in

* Bourgoing's Modern State of Spain. Enc. Brit. Art. Inquisition.

reality (notwithstanding external polish and general appearances), be the real character of some of his fellow-men and women. The Protestant Reformers also did something in the way of persecuting, and even burning to death those who differed from or opposed their doctrines, but the bulk of the particular facts concerning these I also reserve for their proper place in volume 2, under the head of "The Protestant-Reformed Church and State Systems."

When we consider on the one hand the purity of faith and morals which generally distinguished the victims of persecution; and on the other, the proud, pampered priests and prelates, abandoned without shame to every species of wickedness, we can scarcely find words sufficiently strong to express the indignation and horror which arise in the mind when it views the striking contrast, and contemplates such scenes of impiety and crime. Could a religion which breathes peace and good will to men be more basely misrepresented; or do the annals of the human race present a more striking display of the perversity and moral badness of mankind than we have in the case of the Catholic hierarchy? To represent religion as consisting in the belief of certain incomprehensible dogmas, and then to undertake to compel men to believe these dogmas, which they could not possibly understand, and to inspire them to benevolence by racks and tortures and fires, is as absurd as it is impious and profane, and represents the Deity as delighting in the torment and death, rather than willing the life and salvation, of his creatures.

Wherever religion is viewed as consisting chiefly in the observance of a number of absurd and unmeaning ceremonies, it is to be expected that the pure morality inculcated in the New Testament, and in the Ten Commandments, will seldom be exemplified in human conduct. This is strikingly the case in those countries, both of the Eastern and Western world, where the Catholic religion, both Greek and Romish, reigns supreme. Mr. Howison, in his "Foreign Scenes," when speaking of the priesthood in the island of Cuba, says: "The number of priests in Havana exceeds four hundred. With a few exceptions they neither deserve nor enjoy the respect of the community. However, no one dares openly to speak against them. In Havana the church is nearly omnipotent and every one feels himself under its immediate jurisdiction. Most persons, therefore, attend mass regularly, make confessions, uncover when passing a religious establishment of any kind, and stand still on the streets or stop their volantos, the moment the vesper bell begins ringing.

* Kaime's Sketches.

But they go no farther, and the priests do not seem at all anxious that the practice of such individuals should correspond to their profession. The priests show by their external appearance that they do not practice those austerities which are generally believed to be necessary concomitants of a monastic life. The sensual and unmeaning countenances that encircle the altars of the churches, and the levity and indifference with which the most sacred parts of the services are hurried through, would shock and surprise a Protestant were he to attend mass with the expectation of finding the monks those solemn and awe-inspiring persons which people who have never visited Catholic countries often imagine them to be." This account of Mr. Howison we know to correspond with fact; for we have had a like account from a person who had resided in Cuba for some time. Of the city of Montreal in Canada the Roman Catholics number much the largest part of the population. The Church of Rome flourishes there, and its worship is carried on with great pomp and ceremony. We were present there one Sunday of late, June 11th, 1871, when the Feast of *Corpus Christi* was celebrated with great eclat. A grand procession took place, which when moving extended nearly a mile and a half in length. There were the various orders of the nuns, the Gray, Black nuns, etc.; and of the clergy, Friars or Monks, each having (as we suppose) its appropriate place in the ranks. Here and there at intervals in the long procession were schools of boys dressed neatly in black or gray suits, and schools of girls dressed in white with white flowing veils. Some of these boys and girls, we learn, were wards of the church, attending school in the convents; and they appeared intelligent and cheerful. Here and there were societies of men, who, as we were informed, belonged to the Temperance and other orders, and of women who did not appear to belong to any particular order, but were out displaying their zeal for the church. At the head of each column or order was borne a silken flag variously figured, each flag having inscribed upon it the motto of the order, mostly in French or Latin. At intervals they were chanting lustily the hymns of the occasion to time kept by some of the priests; and they sung in French or Latin. The sidewalks along the line of march and the avenues leading to it, as well as the windows and balconies, were crowded with spectators. When the canopy approached under which was borne the *Corpus Christi*, and accompanying which the bishop and other clerical dignitaries were supposed to be, arrayed in their gorgeous robes of office, the Catholics on both sides of the line of march uncovered their heads, and knelt down on the sidewalk or on the side of the street, or wherever they happened to be, until the canopy had passed.

The pains they take in the observation and practice of this ceremony show the Catholics believe the Corpus Christi to have in it some mysterious virtue. They apparently, as shown by their action in this and such cases, receive the words of Christ in his presentation of the bread and wine in the Last Supper:—"This is my body;" "This is my blood,"—in their literal sense, and as covering a meaning no less real than occult and metaphysical.

The following extract is from a modern writer on Italy: "When Vesuvius thunders aloud, or when an earthquake threatens them with destruction, when the fiery streams vomited from the roaring mouth of the volcano roll on, carrying desolation over the plain below, when the air is darkened by clouds of smoke and showers of ashes, the Neapolitans will fall on their knees, fast, do penance, and follow the procession barefooted; but as soon as the roar has ceased, and the flame has disappeared, and the atmosphere has recovered its wonted serenity, they return to their wonted mode of life, they sink again to their former level, and the tinkling sounds of the tumbarella call them again to the lascivious dance of the tarentella." As an evidence of the litigious character of the Neapolitans, the same author remarks: "That there is scarcely a landholder but has two or three cases pending before the courts; that a lawyer and a suit are indispensable appendages of property; and that some of the principal families have suits that have been carried on for a century; and for which a certain sum is yearly appropriated, although the business never advances; and at last the expenses swallow up the whole capital." "The infinite numbers of churches," says another late writer, "is one of the most efficient causes of the decline of the religion of Rome, whose maxims and practices are diametrically opposite to those of the Gospel. The Gospel is the friend of the people, the consoler of the poor. The religion of Rome, on the contrary, considers all nations as great flocks, made to be shorn or eaten according to the good pleasure of the shepherd; for her the golden lever is the lever of Archimedes. The favors of the Church are only showered on those who pay; with money we may purchase the right to commit perjury and murder, and be the greatest villain at so much per crime, according to the famous tariff printed at Rome, entitled "Taxes of the Apostolic Chancery." In a conversation which Bonaparte had with his friends at St. Helena, on the subject of religion, as related by Las Casas, in his journal, the Emperor said, among many other things: "How is it possible that conviction can find its way to our hearts, when we hear the absurd language, and witness the acts of iniquity of the greatest number of those whose business it is to preach to us? I am surrounded with priests who preach incessantly

that their reign is not of this world, and yet they lay hands on all they can get. The Pope is the head of that religion from heaven, and he thinks only of this world, etc. The Emperor ended the conversation by desiring my son to bring him a New Testament, and taking it from the beginning he read as far as the conclusion of the speech of Jesus on the mountain. He expressed himself with the highest admiration at the purity, the sublimity, the beauty of the morality it contained, and we all experienced the same feeling." Had Napoleon, in his youth, taken that which he now heard read as the rule of his life, and lived according to it, what an amount of human suffering and destruction, which he caused, might have been spared, and how much a happier man he would have lived and died himself! Such facts as these we have adduced may give some idea of what the state of morality is in all Catholic countries, and what may be the height of civilization to which they have attained.

Second, from the history and observation of Protestantism.

Now, if we take a cursory glance at the Protestant branch of the Catholic Church, we shall observe a similar spirit in operation in it, as we have seen prevailed in the early Church under the Christian Roman emperors. The Church was at that time split up into a number of sects, each distinguished from the other by its peculiar tenets. Protestant Christians are also divided into a great number of sects, each distinguished from the others by its peculiar tenets and opinions as to mode of worship, Church government, etc. The differences between these sects which, in time past, were wide, are now becoming much narrower. All these sects profess to believe the orthodox Catholic creeds, such as the Apostles' Creed, the Nicene Creed, and, some of them, the Athanasian Creed, and the two orthodox sacraments of Baptism and the Lord's Supper; but their belief in these creeds, etc., are very general, and they all differ from each other in many particulars.

The Protestant Church has been distinguished to a considerable extent by the spirit of persecution which raged with such unmitigating violence in the Romish Church. The Reformation had scarcely been begun in Germany and England, when a series of persecutions were begun against dissenters from the doctrines of the reformers; and it is of late that these persecutions have ceased. Luther and Calvin did their part in this work in the continental countries of Europe; and notwithstanding the unjust and cruel punishments which English Protestants endured at the hands of Popish priests and princes, a short time only elapsed after they had themselves

risen to power before they began in their turn to harass their dissenting brethren with vexations, and persecutions, and fines, and imprisonments, until many of them were compelled to seek a dwelling-place in a distant land. And shortly after the English independents had established themselves in America, they, in turn, set on foot a persecution against the Quakers no less furious than that to which they had themselves been subjected in the country from which they had fled. They apprehended and imprisoned a number of those peaceably disposed and worthy persons, and seized upon the books they had brought out from England with them, and burned them. By a law which had been enacted against heretics in general, sentence of banishment was pronounced against them all; and another law punished with death all Quakers who should return into the jurisdiction after banishment; and it is a fact that four persons suffered death under this impolitic and unjust law.*

Nor did the reformed clergy in Scotland lose sight of that magisterial bearing, which was assumed by the Romish Clergy. Upon a representation in 1646 from the commission from the Church of Scotland, James Bell and Colin Campbell, bailiffs of Glasgow, were committed to prison by the Parliament, merely for having said that "kirkmen meddled too much in civil matters."† And even so late as the middle of the last century, when Whitefield, Wesley, and other earnest and pious men began to address the ignorant villagers of England upon the important subject of religion, "a multitude has rushed together, shouting and howling, raving and cursing," and accompanying their ferocious cries and yells with loathsome or dangerous missiles, dragging or driving the preacher from his humble stand, forcing him and those who wished to hear him to run for their lives, sometimes not without serious injury before they could escape. And these barbarous tumults have in many cases been well known to be instigated by persons, whose advantages of superior condition in life, or express vocation as instructors of the people, has been infamously lent in defence of the perpetrators, against shame or remorse or legal punishment for the outrage. And there would be no exaggeration in affirming that since Wesley and Whitefield began to conflict with the heathenism of that country, there have been in it hundreds of instances answering to this description. Yet the well-meaning and zealous men, who were thus set upon by a furious rabble of many hundreds, the foremost of whom acting in direct violence, and the rest venting their savage delight in a hideous blending of ribaldry and execration, of jibing and cursing, were taxed with a

* All four persons, three men and one woman, suffered in Massachusetts at the hands of the Congregationalists. See Hazard's Historical Collections, Gough's History of the People called Quakers, and Bancroft's History of the U. S., vol. I.

† Kaime's Sketches.

canting hypocrisy or a fanatical madness, for speaking of the prevailing ignorance in terms suitable to the state of the case.

But we need not go back over half a century in order to find instances of religious intolerance among the Protestant communities and churches; our own times unhappily furnish examples of an intolerant and persecuting spirit, though we are happy to be able to say that this spirit is fast disappearing among Protestants. About fifty years have elapsed since the Methodist chapel in Barbadoes was thrown down, and demolished by the "mob-gentry," and with the connivance of the public authorities of that island;* and Mr. Shrewsbury, a worthy missionary at that station, was obliged to flee for his life. Previous to this outrage he suffered insult, contumely, and reproach. He was abused as a villain, and hissed at on the streets, not by the mere rabble, but by the great vulgar, by merchants from their stores, and individuals in the garb of gentlemen. By such characters his chapel was surrounded and partly filled on Sunday, during the hours of worship. Their glass bottles had been previously prepared and filled with a mixture of oil and asafœtida, and all on a sudden they were thrown with great violence among the people, and one was aimed at the head of the preacher; and during the whole time of worship, stones were rattling against the chapel from every quarter. On the next Sabbath an immense concourse of people assembled, breathing out threatenings and slaughter, and from twenty to thirty of the gentlemen mob planted themselves around the pulpit, apparently ready to perpetrate any mischief. Men wearing masks, and having swords and pistols, came galloping down the street, and presenting their pistols fired them at the door; and it was originally designed to have fire-crackers among the females, to set their clothes on fire. At length on an ensuing Sabbath this execrable mob, consisting of nearly two hundred gentlemen and others, again assembled with saws and hammers, axes, crowbars, and every other instrument necessary to execute their infamous purpose, and in the course of a few hours, the lamps, benches, pews, pulpit, and even the walls, were completely demolished. They entered the dwelling-house of the preacher, broke the windows and doors, threw out the crockery-ware, chopped up the tables, chairs, and every article of furniture; tore the preacher's manuscripts and destroyed his library of more than three hundred volumes. All this was done under the light of the full moon, in the presence of an immense crowd of spectators, without the least attempt being made either by the civil or military authorities to check them, while the unfortunate

* Report of the Wesleyan Missionary Society in 1824. Debates in Parliament, 1825.

preacher with his wife in an advanced state of pregnancy had to flee to a neighboring island to save his life! Such is the civilized and humane conduct of gentlemen of the 19th century, gentlemen who would no doubt consider it very unhandsome were they compared to the Vandals and Tartars or to the rude and barbarous savages of Caffraria or New-Zealand. How utterly abominable is the pride, hypocrisy, and deceit of the human heart exhibiting itself in such disgraceful and wicked proceedings? And such emissaries, often weak-minded and giddy-headed, in common parlance having no mind of their own, are sometimes set on to their barbarous work, perhaps by the sneering suggestion of others who are not so easy to be discovered, and, who if they are suspected and questioned, will not only pretend their total ignorance of it, but express their sympathy with the sufferer, although they are themselves the real and prime causes of the whole barbarity. Several instances of this kind have come under our own observation, one of which we shall relate. In a college * which we for some time attended, we had a worthy man for our president, a man, we had reason to believe, of a good Christian temper, and of a sound missionary spirit. He was accustomed to teach certain branches of knowledge, and had a recitation room, as the professors, set apart for the purpose of teaching in. Into this recitation room, situated on the second story, and containing benches, chairs, fire apparatus, tables, books, etc., there was brought one night a full-grown cow; and what must one think was the surprise of the president on his coming next morning to meet his class, at finding such a tenant occupying his recitation room, which last, indeed, was in an exceedingly disordered state! Some of the giddy-brained students who were discovered to have done this disgraceful deed suffered such penalties as the president and faculty thought proper to impose; but any careful observer who was present and knew the circumstances of the president in relation to some other influentials, would at once suspect that those who performed the wrongful transaction were not the prime causes of it, but were incited to it by perhaps the sneering suggestion or remark of another, who, were he earnestly asked about it afterwards, would promptly disclaim all knowledge or intention on his part, concerning it before it happened, and would most likely pretend the deepest sympathy for the sufferer. Such is the deceit of the human heart; and such are the devious ways of the old serpent. This worthy man was soon afterwards made a bishop, which office he now holds.

About the same time of that transaction which we have related

* The college to which we refer here is not that from which we graduated.

as taking place in regard to the Methodist church at Barbadoes, the authorities of Demerara set on foot a persecution against Mr. Smith, a missionary from the London Society, under various pretexts; but his real crime in the eyes of his persecutors was his unwearied zeal in instructing the negroes in the knowledge of religion. He was condemned to death by a court-martial, in opposition to every principle of justice. He died in prison, was refused the privilege of Christian burial, and his friends were prohibited from erecting a stone to mark the spot where his body was laid. The whole details of this transaction present a scene of savage barbarity, scarcely to be surpassed in the history of Europe. The death of this missionary was that event which prepared for the overthrow of the slave system in the British West Indies. It called forth one of Lord Brougham's noblest speeches, and stirred the heart and conscience of the English people. The blood of martyrs is sometimes the seed of freedom as it is of the church; and the execution of John Brown, in Virginia, corresponded in its effects to the murder of this worthy missionary in the West Indies.*

In Switzerland, where formerly Protestantism had its stronghold, the demon of religious persecution has, even in the 19th century, raised its head. The council of state of the Pays de Vaud, at the instigation of the clergy, on January 15th, 1825, published a decree "prohibiting under the penalty of severe fines and imprisonments, all meetings for religious worship or instruction, other than those of the established church." And in the following May another decree was issued, which denounced "fines, imprisonment, or banishment, upon the most private kind of religious assembly, or even the admission of a single visitor to family worship."† In pursuance of these disgraceful laws several ministers and private Christians of high character for piety and learning were banished from the Canton, some for one, and some for two years, cut off from all means of subsistence, unless possessed of independent fortunes, or able to procure it by labor, and some of them perhaps left to starve and perish in foreign lands. If they returned before the expiration of their sentence, death was the penalty to be inflicted. One poor man, a school-master, in the principality of Neuchâtel, was condemned to ten years' banishment. He was brought out from prison, tied with cords, and compelled to kneel in the snow in the public square to hear his sentence read. His crime was that of gathering together a few fellow-Christians in his own house, to whom the Lord's Supper was there administered by a clergyman.

* Report of the Wesleyan Missionary Society, for 1824. Debates in Parliament, 1825.

† Cong. Magazine, June, 1825.

Nor has England been free from the spirit of persecution and intolerance in the 19th century. At Kenneridge, in Dorsetshire, a worthy and excellent individual belonging to the Wesleyan denomination, had attended on a green where twenty or thirty persons were accustomed to congregate on Sunday afternoons to listen to the truths he thought it important to declare. The English Church clergyman of the parish approached with a retinue of servants and commanded him to desist. The preacher took no heed to the command and proceeded to read the text. The clergyman then commanded the tithing man to seize him (which he had the power to do as a civil magistrate, for the clergymen of the Church of England very commonly fill the office of justice of the peace as well as that of a priest). He was directed to be conveyed to Wareham jail; and to every question the preacher put as to the ground of his being arrested, the reverend and worthy clergyman only replied by brandishing his walking-stick. Instances have occurred in which clergymen of this establishment have refused to bury the dead. At Chidds Ercal, in Shropshire, the child of a poor man was refused interment, and the father was obliged to carry it six miles before he could inter it in a cemetery. At Catsfield, in Sussex, a similar infamous act was committed. At the moment the bell had tolled, when the earth was about to fall upon the coffin, and when the relations standing by wanted all the consolation which religion can afford, at this moment the clergyman appeared, but advanced only to give pain to the mourners, and to agonize their hearts by saying: "Now that you have waited an hour until it suited me to come, I will not inter your child! I did not know that you were dissenters; take your child somewhere else, take it where you please, but here it shall not lie in consecrated ground." Just as if all places on the surface of the earth were not equally consecrated; or, as if a cemetery or church-yard was a better and holier place to inter a dead body than any other place a person might choose. It is certain that a cemetery or churchyard, in the common acceptation of the term, has no superior sanctity over any other spot of ground; its superiority in this respect is merely imaginary, and arises to the mind from the custom of mankind in all the ages of history being to bury their dead in certain places set apart for that purpose. In America, where many of the old superstitious notions have been given up, people very commonly, especially in New England, have each family their own burying ground on their own farm. This is as good a plan to follow as any other a person may choose with respect to the place of burial of the dead. This English family, however, to which we have just alluded, were not allowed to bury their child in the church-yard, and had to carry it eleven miles from

the abode of its parents before they consigned it to its kindred dust in what they considered consecrated ground.

At Mevagissey, in Cornwall, the rector refused to allow the corpse of a dissenter to be brought within the church, and, therefore, read the burial service in the open air. At Wellingborough, a clergyman, in opposition to a custom which had been practised for sixty years, issued orders that no bell should toll when a dissenter expired. He boldly avowed "that he would never allow the passing bell to be tolled for a marriage when the parties were dissenters." In reference to this case an appeal was made to the bishop of Peterborough, who wrote a long letter on the subject, in which he defended the conduct of this Wellingborough rector. At Newport Pagnel two persons of decent appearance, teachers of Baptist societies, were collecting subscriptions for the erection of a new place of worship. After arriving at the residence of the parish clergyman they were taken before a clerical magistrate, who, upon the evidence which the other clergyman offered, that they were rogues and vagrants, committed them to Aylesbury jail, where they were confined for three weeks, in common with the basest felons, among convicted thieves of the most abandoned character; nay, more, they were sentenced to the tread-mill, and kept at hard labor there, though during the whole time of their incarceration one of them was afflicted with spitting of blood. Their papers were seized upon, their money was taken from them, and by means of it the expense of sending them to prison was defrayed.

Since the time to which these instances refer the "Society for the Protection of Religious Liberty," has been formed, and has brought forth to public view many similar instances, some of them of a more barbarous nature. And were it not for the protection which this society affords to the victims of religious intolerance it is highly probably that vexation, persecutions, insults, fines and imprisonments on account of differences in religion would now be much more common than they are in England. Were such individuals as these to whom we have alluded permitted by the law to carry their intolerant spirit to its utmost extent, dissenters would have no security either for their lives or their property, and the fires of Smithfield might again be kindled to consume the bodies of all who refuse to conform to the dogmas of a national Church.

The main history of the Protestant Churches since the reformation, in which there is much of a persecuting spirit displayed, we have purposely left untouched in this review. There are certain subjects we have to deal with in the latter part of this book, which will require these historical facts to which we now allude to illustrate them. By the time, therefore, the reader has advanced that

far he will be able to learn much more as to the moral character of the reformed Churches as represented in history. It would have given us pleasure in our review thus far to have been able to present before the eye of the reader a more cheerful picture of the moral character of the civilized nations, and of the Christian Church; but facts are stubborn things, and there is no resisting the force of the evidence which they adduce. We intend, however, to relieve some of the dark shades of this picture by exhibiting some faint radiations of truth and benevolence, which appear amid the surrounding gloom. The dawn of a brighter day has appeared to gild our horizon. The Pope's temporal power has been taken from him, and his spiritual power and influence will continually henceforward wane, to be consumed and destroyed gradually until its end. Some of the Protestant establishments also are failing, that of the Irish Church having completely given way while one of an improved model has taken its place. Substantial knowledge is being more generally diffused among all classes of the people; the shackles of despotism are bursting asunder; the darkness of superstition is gradually dispelling; the spirit of persecution is borne down by the force of truth and of common sense; and the rights of conscience are being more generally recognized. Philanthropic institutions of various descriptions have been established; missionary societies are extending their labors to almost every land; and now the far-off continents are to some extent coming under the influence of Christian civilization.

The light of science now shines with a greater lustre than at any previous period of which history informs us. The Telescope has opened up to us distant scenes of the universe, and has enabled us to calculate the distance, character, and motions of the moon and planets. The microscope has introduced us to the invisible worlds of matter far beyond the ken of the unassisted eye. The electric Telegraph enables us to communicate momentarily with all parts of the earth. The Magnetic needle directs our course around the globe or to any point beyond the seas. The power of steam has been greatly developed to the use and convenience of mankind. The progress of invention has tended greatly to abridge human labor. Agriculture is practised more skilfully and advantageously than in former times. The arts, both useful and ornamental, are extensively cultivated. The use of the art of printing puts substantial knowledge within the reach of all, even the poorest. Literature and practical science are the order of the day in our schools and academies, and the youth of a dozen of years, whose time has been well employed in study, possesses more definite science at his command than the aged man of five centuries ago. But here the question

arises: is it possible, judging from what we know of the past history of mankind, to bring the inhabitants of this world to a general observance of the laws of benevolence, which is the true index of high moral character and civilization? To such a question, we have answered frequently before that man has it in his power to cultivate the spirit of benevolence or of malevolence, either of which he chooses; but in this connection we answer it thus: that *whatever man has accomplished man may accomplish*. Amidst the darkness, depravity and wickedness with which the earth has been generally enveloped individuals have occasionally arisen who have shone as lights in the moral world, and exhibited bright patterns of true Christian temper and of active benevolence. The founders of the Christian faith appear to have belonged to this class. The Apostle Paul had his mind imbued with a large portion of the spirit of philanthropy. He voluntarily undertook a tour of benevolence to the nations, and notwithstanding the persecutions, the reproaches, the stripes, and imprisonments which he encountered; and notwithstanding the perils in the waters, perils of robbers, perils by his own countrymen, perils in the city and perils in the wilderness to which he was subjected; and in the face of death itself, he prosecuted, with a noble heroism, his labor of love, purely for the sake of promoting the best interests of mankind. All who at the same time engaged in the same benevolent undertaking sacrificed all private interest and selfish consideration in order to bring men to a belief of the doctrine which they had themselves espoused.

In modern times many individuals have arisen and distinguished themselves and reflected honor on their race by the benevolence which they displayed. The name of John Howard is familiar to every one who is at all acquainted with the annals of philanthropy. This excellent man devoted his time, his strength, his genius, his literary acquisitions, his fortune, and finally his life, to pursuits for the benefit of humanity and to the unwearied prosecution of active benevolence. He travelled over every country of Europe and into the adjacent regions of Asia, impelled by the spirit of true Christian love in order to survey the mansions of sorrow and pain, and to devise schemes for the relief of human wretchedness wherever it existed. And in the execution of this scheme of benevolence the energies of his mind were so completely absorbed, that he never suffered himself for a moment to be diverted from his purpose even by the most attractive of those objects, namely, the pleasure of music, which formerly possessed all their most powerful influence upon his curiosity and taste. Also, Walter Venning, who has been denominated by Prince Galitzin the Second Howard, followed the course of his illus-

trious predecessor, and with the most fervent Christian zeal devoted his short but very useful life to the alleviation of human misery, and to the promotion of the best interests of thousands of wretched individuals, who were all but lost. He withdrew from the ordinary routine of what is termed genteel society in order that he might devote all the energies of his soul to benevolent occupations. He commenced his philanthropic career by co-operating in the organizations of "The Society for the Improvement of Prison Discipline," which was founded in London in 1816; and he afterward visited the prisons in the cities of St. Petersburg, Novgorod, Tver, Moscow, and other cities in Russia. The prisons, hospitals, workhouses, madhouses, houses of correction, and the abodes of misery of every description in St. Petersburg were visited by him day after day; and many a prisoner bowed down with affliction and iron, was cheered, instructed, comforted, and served by his ministrations; for, it is said, that his philanthropy extended both to the bodies and souls of men. This truly benevolent person died in the city of St. Petersburg in the year 1821, in the fortieth year of his age.

In our own day we have had a noble example of generosity and benevolence in George Peabody. An American by birth, having amassed a large fortune by the industries of trade and commerce in London, he liberally bestowed a goodly portion of it to provide shelter and comforts for the poor of that vast metropolis. In his native state he founded libraries for the instruction and enlightenment of the people, and his generous beneficence, and magnificent donations to worthy objects, ensure to him the respect of mankind in after ages. Men, who have any pecuniary legacy to bequeath to mankind, should, like George Peabody, always keep the *poor* and the *indigent* prominently in view. As the poet Homer, for the honor of whose birth-place, we are told by Cicero, several rival cities disputed, so this worthy man had the honor of his burial amicably disputed by two great nations, England and America.

Many other examples might be adduced from the history of our times, and illustrious characters now living, both men and women, to demonstrate that a noble and disinterested benevolence is a principle capable of being developed and exercised even in the present degenerate state of mankind. We find parents sometimes displaying a high degree of benevolence toward their children; and sacrificing their ease and their personal interests in order to secure their health, their happiness, and their future good. We find bosom friends as David and Jonathan, and as Damon and Pythias, rejoicing in each other's welfare, and encountering difficulties and dangers in promoting the interests of the objects of their friendship. What then

should hinder such dispositions from becoming universal? What should hinder them from being cultivated and exercised by all rational beings? Would not the universal exercise of such dispositions be highly desirable? Would it not tend to banish war and discord from the world, and promote peace on the earth and goodwill among men? Why then are such dispositions so rarely to be met with? Not because the universal exercise of them is a thing impossible, but because men, actuated by pride and selfishness, are unwilling to give full scope to the cultivation and exercise of the benevolent affections; because they have never yet persisted in their endeavor to bring these into full operation. If all the energies of the intellect, and all the treasures which have been expended in fostering malignant passions, and in promoting contentions and warfare, had been devoted to the great object of cultivating and exercising the principle of benevolence, and distributing happiness among men, the moral, yes, and natural, aspect of our globe would long ago have assumed a very different appearance from what it now presents to view.

We have examples before us not only of a few insulated individuals, but of societies where the principle of active benevolence to a greater or less degree pervades the whole mass. The people denominated Quakers have always been distinguished for their humane and peaceable dispositions, their probity and hospitality towards each other, their unostentatious liberality to indigent and suffering humanity, the modest cheerfulness of their manners, their opposition to war, and the active zeal they have displayed in promoting the moral welfare of mankind. We give the following extract from a daily paper of February 25th, 1872: "M. Drouyn de Lhuys, in his capacity as President of the French Société des Agriculteurs, has written a letter which sets forth the help given to France by the English Quakers during the war. These generous people have bestowed in the most unostentatious way aid to the extent of four millions of francs in the period named. The sum has been proved by regular accounts written by M. de Lhuys, kept with the exactitude of a commercial house. He expresses the gratitude of a Frenchman in manly and affectionate terms, not only for the help given, but for the delicate manner in which it has been bestowed. There is something fine and touching in these friends, the professed advocates of peace, thus giving out of their moderate possessions to repair the ravages of war." Thus the spirit of benevolence has to make repairs for the damage done by the outworkings of the spirit of malevolence; and it is quite as important that men should do the justice to themselves and to mankind, of restraining and eradicating the spirit of malevolence, that

delights in war and every evil work, as it is that they and all others should cultivate and exercise the spirit of benevolence, which delights in all that is good. The Quakers are also distinguished for the simplicity and purity of the creed they profess. The Moravians are likewise distinguished for their affectionate intercourse with each other, the liberality of their dispositions, the peaceableness of their temper, the purity and simplicity of their lives, and their missionary efforts for converting the heathen to the truths of the Gospel. Would that the whole race of mankind were Quakers or Moravians (if they will not be more perfect), notwithstanding their peculiarities of opinion. With all their faults society would then present a more beautiful and alluring aspect than it has yet done; peace and industry would be promoted; the fires of persecution would never be kindled; the sciences and the arts that tend to peace and order would be cultivated; philanthropy would be exercised by the nations; and the people would cultivate the spirit of benevolence toward each other, and learn war no more.

Other things which tend to illustrate further the probable permanency of the cosmical phenomena as to forms, changes, &c., in the main as now existing.

After our review of the moral character of mankind in its two aspects of bad and good; and after having illustrated that man himself is the former of his own character and determines which of these it shall be; we now think it proper, for the sake of digression, variety and information, to turn the attention of our readers to other things connected with our subject *which tend to illustrate further the probable permanency of the cosmical phenomena as to forms, changes, &c., in the main as now existing.*

First, then, we may state here, as we have done before, that there is no evidence except what is derived from such records as are susceptible of only a like literal interpretation as is given to the general ancient cosmologies, which tends to show the contrary of the probable permanency of the cosmical phenomena.* But having before brought for-

* It is easily seen, however, that the question of the permanent existence of the cosmos as to the phenomena of forms, changes, etc., can only be of secondary importance if it be allowed that the substance of these bodies has never not existed. If any one should undertake to say that these bodies assumed or were given their present forms and motions at some period of the past from their substance existing before in a nebular state, it would be well for such an one to say at what time that change took place, and how long their substance had existed in that supposed nebular state before it became into these globular forms, and in what state it existed before it became into the supposed nebular state. For if men allow themselves

ward arguments which tended in general to illustrate this as to the phenomena of form, motion, &c., the reader will readily understand that these arguments apply to the existence of man and of all other animals, and to plants, as well as to the phenomena of the celestial spheres, to light, colors, &c., for all things are embraced in the cosmos; and will now be pleased to accompany us while we illustrate this subject in general and at length.

Solomon was a wise man and uttered the truth when he said that there is no new thing under the sun. Paul, or any other, was a wise man also, who said: If a man shall not sow neither shall he reap, and whatsoever a man soweth that shall he also reap. It is a fact known to all common observers that all plants and animals bring forth after their own kind. The farmer does not expect to reap if he do not sow or plant; nor does he expect that a blade of rye will spring from a grain of wheat that he has sown, neither of barley or of buckwheat or any other than a blade of wheat; and he is never disappointed in this expectation. Nor does he expect that any of his domestic animals will bring forth other than young of their own species, unless he has crossed the species for the purpose of producing a hybrid, as for example, a mule, the result of the crossing of the ass and horse species.

Of all the known species of plants—and there are reckoned as known, we believe, about ninety thousand species—there is not one that produces other than its own kind. Also, each of these species is distinguished by having varieties in it, and each of these varieties brings forth after its own kind. For instance the species oak, of the genus *quercus*, is distinguished by such varieties as the white oak, red oak, etc., as almost every one knows, and each of these varieties propagates after its own kind. The seed of the red oak will bring forth a red oak, that of the white oak a white oak, etc. Also, of the birch species there are several varieties, and each of these brings forth its own kind. And so it is with all the other species of plants and their varieties, unless, as some say happens, and which is not improbable to take place, that a different variety may arise within the same genus from the pollen of a plant of one variety falling upon and fertilizing the seed of a plant of another variety of the same genus, whence a new variety, a cross between these two varieties of the same genus or species might arise.

to launch out into the region of conjecture with respect to this subject, there is no knowing where they will terminate their speculations and theories concerning it.* The "Nebular Hypothesis" and its offspring "evolution" imply an infinite series of cosmoi.

* See Herbert Spencer's "Principles of Philosophy," in which he undertakes to illustrate an infinite series of Evolutions and Dissolutions of the forms of Matter, which is as impossible to conceive as infinite space or infinite time, *i. e.*, it is to us as nothing.

Of all the known species of animals—and there are reckoned as known nearly as many as there are of plants, without reckoning the microscopic species—the general natural rule is that each species, as well as their several varieties, brings forth after their own kind. This they do permanently, unless, as we have said before, a hybrid is produced by the arbitrary government of man. Thus in the animal kingdom propagation according to species and kind is the great rule; hybridism the very rare exception. But it is an absolute fact, to which there is no known exception, that no plant or animal of any kind whatever can be produced unless the seed exists before from whence it is to spring. So then, not only are all plants and animals propagated in succession from their own kinds, but neither plants nor animals of any kind could exist had not their seed pre-existed to give them birth. And conversely the seeds could not exist had not the plants and animals existed to produce them. The seeds, therefore, of all the plants and animals in the earth must have always existed and consequently the plants and animals themselves must have existed and been propagated, were they not produced from non-existence at some past time in some way of which we have no experience.

Now propagation according to kind has taken place in all the periods of time of which we have historical records. These last go back in the case of Egypt and some other Eastern nations for a space of nearly 4000 years. This is the extent of time to which we have the written experience of mankind, (unless we receive the writings of the Hindoos and Chinese, which extend back for many thousand years before, and which are doubtless as authentic as the Egyptian records) and thus far may we profit from it. What has, then, existed and been taking place with such undeviating regularity for such a length of time, and what we see now existing and taking place, with no signs of its discontinuance, we may be allowed to suspect is permanent, always existing, always taking place, since no evidence exists to the contrary.

But geology, or the knowledge which man has obtained of the nature and construction of the earth's crust, may have something to teach us concerning the earth. This knowledge is indeed very limited, since geology has only been pursued for a short time, but it has nevertheless already done something, as did astronomy a good deal, towards the removal of erroneous and superstitious notions. The latter of these, which is a definite science,—*i. e.*, accounts well for all the celestial phenomena concerning the motions and modes of existence—does away with the old Hebrew idea of creation from every mind that has made it a study. Geology, which cannot be called a defi-

nite science, but only an accumulation of scraps and gleanings of knowledge derived from observation and examination of small parts of the earth's surface, has still so far effected as to show the falsity of the old idea of the earth and all visible things having been made to exist out of nothing in six literal days. Though the earth's centre is about four thousand miles from its surface yet geologists in their researches have not penetrated more than a mile or two* of that distance, and this only in detached spots; while the great extent of the earth's surface, and its whole interior, remain still unexplored. From this it need not be inferred that scientific men must necessarily be altogether ignorant of the approximate density and consequently weight of which the bodies must be which go to make up the earth's interior and central regions; this knowledge they claim to come to, at least approximately, from a consideration of the earth's position in space and of the force of gravity which it exerts on the moon and planets situated at different distances from it. About three-fourths of the earth's surface is covered with water. Take a small artificial globe, such as they use in schools, and bringing the south pole under your eye and then viewing it all round you will see the great disproportion of the extent of the dry land to that of the water upon the earth's surface. The bottoms of the seas, lakes, and oceans then, as well as most of the dry parts of the surface of the earth remain unexplored by geologists. Hence it is seen how little information, comparatively speaking, geology affords us concerning the earth. But it gives us some information. It proves, as well as does the common experience of mankind, that parts of the earth which are now dry and subject to cultivation were at certain periods of the past a prey to the waves. We have seen a house in one of the western counties of New York State built of such limestone as is mainly made up of water shells, some of the shells larger than our fist, and these stones are from the farm on which the house is built. A great part of this section of country, especially the valley parts, present a like geological formation, indicating that at some time it was covered with water. There are large lakes in the vicinity, and one might suppose, with respect to the particular section of country to which we allude, that at some time in the past the waters of Lake Ontario extended to a considerable distance south of its present southern boundary, but that the gradual enlargement of the St. Lawrence river by the constant flow of the water through it, by means of which a greater volume of water could pass through from the Great Lakes to the

* This means below the level surface. If we consider the heights of some mountains which are the result of upheaval from below the earth's surface, we find geologists have knowledge of the interior of the earth at certain places for twelve or fourteen miles.

Atlantic, may have drained it by degrees. There is, however, no sufficient reason to believe that at any period of the past the waters at large covered a greater extent of the earth's surface than they do now, or that more than comparatively small portions of land are at any time lost or set free by the water. People living near the sea shore have constant experience of the wearing effects of the action of the waves on the coast. This is especially the case where the coast barrier is of a soft clayey character. When it is of hard and resisting substance, as rock, the wearing effect is not so noticeable during the lapse of two or three generations of men. But the effect on some coasts by the waters heaping up sand and other material, is that land is made. This is noticeably the case around some of the great lakes of North America; and some geologists go so far as to say that all the land between the Mohawk and Hudson rivers and the Atlantic Ocean, comprising a large part of eastern New York and New England, has been thus made, and by upheaval.

Also, at the mouths of rivers there is much land made by deposits from the waters. The delta of the Mississippi is of this character, the extent of which is at least 12,300 square miles, and this is computed by Sir Charles Lyell to have been 33,500 years in the course of formation. The Ganges performs even a greater work of depositing than this. In the four rainy months, at 500 miles from its mouth, it was found to bear seawards 577 cubic feet of solid matter per second. Its annual discharge has been computed to be 6,368,077,440 cubic feet; an amount of matter equal in weight to sixty great pyramids of Egypt, although the base of that immense pile covers eleven acres, and its apex is 500 feet above the level of the plain. Yet even this does not measure the depositions which are going on in the upper part of the Bay of Bengal; for it is considered the Brahmapootra contributes as much as the Ganges does to the sedimentary accumulation. From this we may form some conception of what great extents of land there are constantly being made by the depositions of all the rivers in the world which empty into the seas and oceans; for every river bears down to the ocean an amount of matter in proportion to the volume of water it discharges, and the nature of the country which it drains.*

An admirable illustration of this subject is offered to us in the lake of Geneva. The river Rhone passes through this lake. It enters the lake at the upper end, its waters discolored by the mud; but on leaving the lake its waters are transparent blue, the mud having been deposited in the lake. As this has been going on for cen-

* See, further, Lyell's "Principles of Geology," pp. 273, 283.

turies we may expect to find some evidences of the work of the river. This is given us in the alluvial tract which stretches from the head of the lake for six or seven miles. It is a marshy plain, higher than the level of the water, and occupying what was once the bed of the lake. If this state of things continues the Rhone will eventually fill up the whole lake. The rate of the advance of the delta may be gathered from the fact that the Roman town Portus Valesia, which stood on the margin of the lake is now more than a mile and a half inland, the river having added to its delta this quantity in about eight centuries. By soundings it is found that the mud deposits reach some two miles from the river's mouth. On these alluvial tracts wild grasses are generally found growing, that is, species peculiar to the waters and to marshes, and these are often mixed with some of the cultivated grasses, the seeds and plants of which have been brought down and deposited by the waters of the river.

Examples of the loss of land by the waters, especially by the action of the waves on coasts, are of frequent occurrence on the coasts of Britain. Thus, on the coast of Yorkshire from Bridlington to Spurm, a distance of 36 miles, it is computed that the waves eroded $2\frac{1}{4}$ yards annually, so that the sea has encroached two miles within the last fifteen centuries. Many old maps of Yorkshire, indicate that villages once stood where now the waves hold undisputed sway, and ports mentioned in past history are no longer to be found. The same destruction is taking place on the coasts of Norfolk and Suffolk. The sea-port towns are being driven back by the encroaching waters. The sites they occupied in past years now form their harbors. Between Cromer and Mundesley, according to the Ordnance survey of 1838, the cliff has receded at the rate of fourteen feet a year. On the same coast, as in Yorkshire, many villages are only historical remembrances. The church-tower of Eccles is still seen rising out of the seasand, but all other remnants of the village have long since succumbed to the action of the waves, or have been covered with sand-hills which are dispersed along that coast. Dunwich, on the coast of Suffolk, offers another remarkable instance of the conquests of the sea. What is now a small village was once a large and flourishing seaport; records of the town are preserved from Domesday book, from which we learn that the sea must have encroached on the land to the distance of several miles. Also, the Goodwin sands, which are from three to seven miles from the coast of Kent, nearly opposite to Ramsgate, tradition informs us were once the estates of the Earl Godwin. England is, however, indebted to the sea for a recent gift of large tracts of land in Lincolnshire, and Cambridge-shire, and the 300 miles called the "Humber Warp." Other countries

are far more indebted; Holland and Denmark are well-nigh wholly the products of the German ocean deposited in the most recent geological periods; and Tyre and Sidon, celebrated sea-ports of Phœnicia, mentioned in the Scriptures, are now several miles inland.

Changes corresponding to these are taking place on the coast of Italy, and to a greater or less extent on all other coasts. When any portion of land has been gained from the water, man advances on it, bringing his plants and animals with him, and the water grasses being subdued, these are propagated thereon. Or if for the course of ages there be no civilized men to occupy it, the seeds of vegetables from the old land become more or less scattered thereon, and the roots of vegetables, large and small, from the old land, become gradually expanded thereon, so that if the soil be adapted to their growth these grow up, and in the course of ages all this new land may become covered with vegetables large and small, as the old land. The reader should remember the slowness with which these natural events take place, and in a low state of civilization man scarcely perceives them. The Irish and Danes, when they contemplate their peat-bogs* of such great extent, and some of them we suppose from 100 to 150 feet deep, may well betlink themselves on the millions of years during which these vegetable deposits were being made, and should glorify their great Creator, who has arranged and superintended this whole process.

Another subject which it is proper to mention in this connection is that of earthquakes. At different periods of time portions of the earth's surface have been elevated above the general level by the action of internal forces, igneous or aqueous, or both of these combined in the production of steam, and corresponding portions have been depressed, in some cases doubtless lost, by being submerged in water. Thus the differences of level on the land surface of the earth have arisen either from the hills and mountain ranges having been pushed up by internal forces, or from the land on both sides of these having subsided. Elevation and depression have doubtless always been taking place on the earth's surface. The universal action of water is to level, and it is considered that should no other cause interfere with the degrading and filling up which is carried on by every rain drop, river and ocean, the surface of the earth, after a requisite number of ages, would become level. This however, can never be the case, for there exists a force in the earth which constantly opposes the action of water. Here, as in every domain of nature, is

* The peat-bogs are incipient coal-beds; and, conversely, the coal-beds are ancient bogs.

a finely adjusted balance, the aqueous agency on the one hand and the igneous agency on the other, the one wearing down, the other elevating; the one filling up and making the surface even, the other disrupting and throwing existing arrangement into disorder. The igneous action is exerted in three ways; in volcanoes, in earthquakes and in the gradual upheaving and subsiding of portions of the earth's crust.

Many facts go to prove that in the earth's interior, and not far from its surface, there are vast accumulations of igneous matter. This sometimes finds vent in great quantities by means of volcanoes, of which there are known to be 225 active ones (or rather volcanoes which have been known to erupt within the last 150 years), besides a large number of inactive ones, on the earth's surface. These accumulations of fire, as we have intimated, are in detached places of the interior, and the water percolating through the fissures in the rocks finds its way into these fiery places, and thus a large amount of steam is generated, which, in its efforts to escape, sometimes finds vent by the mouths of volcanoes, and sometimes produces the disturbances of the earth's surface which are called earthquakes, sometimes causing the destruction of large cities and flourishing districts, and the elevation of certain parts of the earth's into hills and mountain ranges and the consequent depression of other corresponding parts. If the whole interior of the earth were one mass of molten matter, as some geologists are wont to suppose, then according to the laws of hydrostatics, the pressure exerted at one point by the expanding steam must be felt by the whole liquid mass; for liquids transmit pressures equally in all directions; hence, the same force which throws into action one volcano must also cause all the neighboring volcanoes to erupt; and the same force which throws into disturbance one portion of the earth's surface, transmits an equal disturbing agency to every other part. This argument finds a remarkable illustration in one of the Sandwich islands. Mauna Loa is a volcano, frequently active; there is a crater near its summit, 10,000 feet above the ocean level; 6,000 feet upon one flank of this mountain is another crater, Kilauea. It often happens that while Loa is in action, the lava in Kilauea is molten, yet undisturbed. It appears an inevitable consequence, that if these craters both derive their lava from the same reservoir, the force which propels the molten matter to the higher crater must cause a jet of lava to be thrown from Kilauea to a similar height. That simultaneous disturbances would take place in each volcano, if their ducts led to the same reservoir, may be fairly inferred from the fact that we have numerous accounts of volcanic action occurring at the same moment at many distant points. For

example, a violent earthquake visited Chili in 1835; at the same moment the shock was felt over a wide area; the two volcanoes, Vantales, and Osorno, burst into action; and at Juan Fernandez, 720 miles distant, a submarine eruption took place. Thus, the commotion, in some deep-seated reservoir, affected a tract of country 900 miles long and 600 broad; and these examples show that some of the subterranean reservoirs are of greater extent than others; and also determines that the whole interior of the earth, reckoning at any distance from its surface, is not a mass of liquid fire.

The ordinary elevation and depression of the earth's surface takes place frequently when by the fluctuations of the temperature of the earth's crusts the rocks expand or contract, in the former case of which an elevation takes place in the surface immediately above the locality which experiences the expansion;—in the latter case, especially when the contraction or cooling down takes place rapidly fissures are made in the rocks, which admit the water to the igneous regions. When the shock takes place in the interior it is propagated on all sides from the centre of disturbance in a wave, which reaches the surface, and as it rolls wider and wider from its centre causes all the phenomena exhibited in an earthquake, gradually decreasing in its power until it becomes imperceptible. There may be earthquakes of which the igneous agency is the main cause; but it is a remarkable fact that all volcanoes, and ranges of volcanoes are in the neighborhood of seas and oceans.*

It would be much beyond the limits of our space to chronicle the destructions which the eruptions of volcanoes have brought on human beings; but it may be permitted us to mention the effects of some remarkable earthquakes. The effects of some of these were felt over vast regions of the globe. One occurred at Lisbon in Portugal, on the 1st of November, 1755, the effects of which were felt over an area four times as large as Europe. The shock was preceded by no premonitory symptoms; but, with a tremendous roar, the city reeled and fell. It seems from observations made on scientific principles that the centre of disturbance was some eighty miles from Lisbon, out at sea. The actual scene of the gaseous explosion must have been deep-seated, since its effects were felt over such a large area. The water rose suddenly twenty feet in the West Indies. The great lakes of North America felt the movement. In Scotland, Loch Lomond rose on one beach more than two feet, the water not par-

See Humboldt's *Cosmos*, vol. V. for an elaborate account of volcanoes.

* Of the 225 active volcanoes 155 or two-thirds are situated on the islands of our globe, and 70 or one-third on the continents. In the interior of the basin of the South Pacific ocean and around it are found 198 or nearly seven-eighths of the whole number.

ticipating in the lurch of the land. The waves of disturbance extended to the very north of Europe. In six minutes, 60,000 people in Lisbon perished. Many had assembled on the wide expanse of the new marble quay out of the way of the falling houses, when suddenly the quay with its living throng sunk with many ships in the harbor, and not a body, nor the splinter of a wreck, was ever known to rise from the watery depths. We can only suppose that a fissure opened beneath the harbor, and, after engulfing the whole, suddenly closed in. In this earthquake a remarkable proof was offered of the fact that the earthquake wave is more readily propagated in some formations than in others. The lower part of the city which rested on blue clay was most severely shattered, while that part of the city which was built on limestone and basalt escaped. The wave movement passed along the earth's surface at the rate of twenty miles an hour; the sea wave which in such cases usually follows the land wave at a much slower pace, rolled about four miles in the same time. The sea wave is generally the cause of as much loss of life as the actual violence of the shock. This may be well understood from the fact that at Cadiz, the wave was sixty feet high. But the reason why the waters of Loch Lomond did not participate in any perceptible degree in the lurch which the land gave is that that lake is of so small an extent, and that the water wave travels so much slower than the land wave.

South America has for centuries been the scene of repeated earthquakes. A few years after Lima was built, in 1582, the city was ruined, and since then the catastrophe has been repeated some twenty times. In all the cities of that neighborhood the ecclesiastical year is full of anniversaries commemorating terrible overthrows or marvellous escapes. But none of these calamities seem comparable to that which has paralyzed that country some four years ago. On the 13th and 16th of August, 1868, two earthquake shocks passed over Peru and Ecuador, ruining every town and city, and leaving between two and three hundred thousand people dead to putrify in the tropical sun. Arica, a sea-port town, was completely covered with the wave. One who was present at the catastrophe, and who survived it, states, that upon the first shock, at a quarter past five in the afternoon, he with some others jumped upon a barge, when the great wave carried them on its crest, completely over the town, *above the spire of the church*, and landed them unharmed nearly a mile inland.

The chief geological effect of earthquakes is shown in the permanent alteration of the level of the land. In 1822, the coast of Chili was raised some two feet, while further inland the elevation

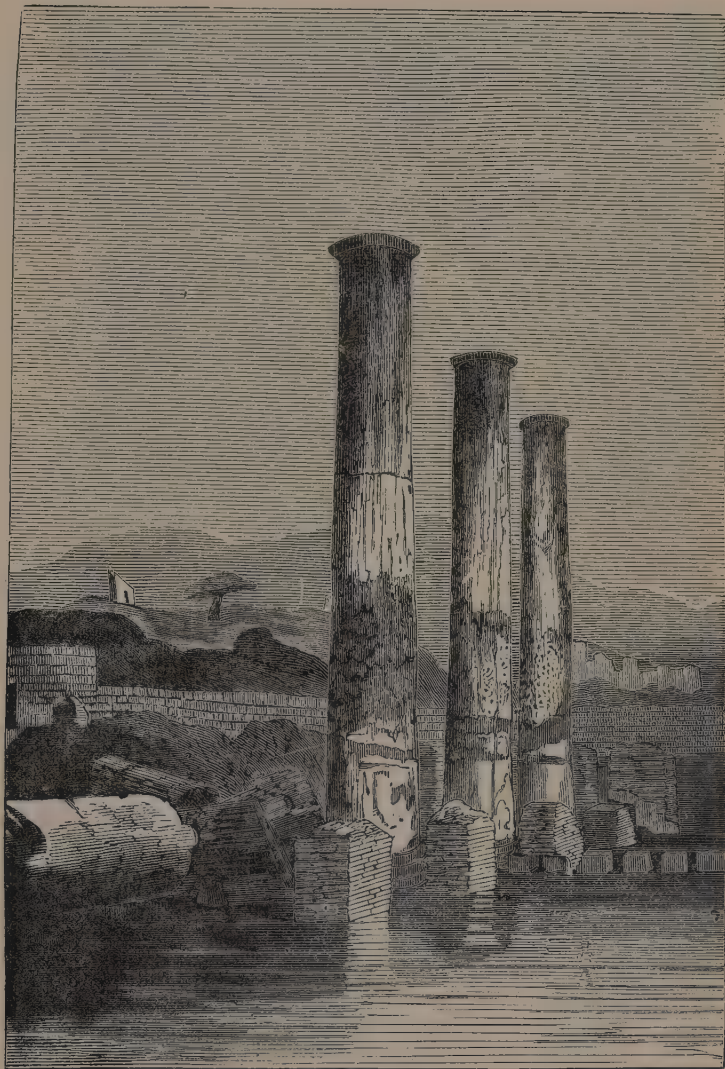
was more than double this extent. In 1855, the coast of New Zealand, for ninety miles, gave evidence of a rise of nine feet. (For many other facts illustrative of the alteration of level in all parts of the world as a consequence of internal disturbances, the reader may consult Lyell's *Principles of Geology*, vol. II.)

But there is found to be a gradual alteration of level taking place on the earth's surface, not attended with convulsive movements, which is more important than those local variations. Observers find it difficult to establish these facts, because there is no standard which is not itself subject to alteration. Careful investigations, however, of the coast of Sweden has shown that most of the Scandinavian peninsula is rising at the rate of four feet a century. The coast is favorable for the observation; there are no tides in the Baltic, and the cliffs which line the coasts descend perpendicularly into the sea. Few other places present the same advantages for observation. The water level has been repeatedly marked, and the rise judged by its change. It has also been observed that the bed of the South Pacific Ocean is sinking in these ages. Some judge thus from the fact that the beds of the coral formation are found far below the depth of twenty fathoms, below which, it has been said, the coral insect could not exist from the pressure of the water being too great; just as if any man of sane mind could believe that an insect which exists under the pressure of twenty fathoms of water would be prevented from existing at five times that depth "by its pressure." There are doubtless portions of the bed of the Southern Ocean sinking to correspond with the elevations which are taking place in the Northern hemisphere, for, for every elevation there is a corresponding depression on the earth's surface.

One well known proof of the repeated oscillations of the earth's crust is that which is offered by the temple of Serapis, near Puzzuoli in the Bay of Naples. The ruins of this temple consist of three pillars of marble, hewn out of solid blocks of more than forty feet high. The history of this remarkable temple appears to be as follows: From certain inscriptions discovered in the vicinity, we learn that in the year 105 B. C. a temple dedicated to Serapis existed on the shore. In 1828, the handsome mosaic pavement was discovered five feet beneath that from which the pillars rise. The existence of this pavement indicates that the land must have sunk, and the present floor have been raised above the level of the water. In the early part of the 3rd century, the temple was repaired and beautified by the Emperor Alexander Severus. At what time it was deserted, it is not known, but, in 1749, the following facts were brought to light by excavating: That when the sea broke in the salt water caused a

Plato, writing about 400 B. C., speaks of an island called Atlantic, larger than Lybia and Asia, which had existed beyond the Pillars of Hercules and from which there was a passage to other islands and thence to a continent still beyond (*i.e.*, America); that this island was destroyed by a deluge and an earthquake, its inhabitants, the Atlantides, being submerged with it. Aristotle refers to this as an accredited opinion in his time.

hot spring which exists to throw down a dark calcareous deposit two feet thick. Above this a layer of volcanic tufa was found reposing, which must have been ejected by the neighboring volcano. This deposit is not regular, varying from five to nine feet in thickness. The eruption seems to have formed a barrier which kept out the



THE ANCIENT TEMPLE OF SERAPIS, NEAR PUZZUOLI. NAPLES.

waters of the sea, so that the hot spring continued to deposit its carbonate of lime, but without any marine admixture; thus about two feet more were added to the matter which embedded the bottom of the column. More volcanic tufa was now placed upon the lime

deposits either by a storm or another eruption, making a total deposit of eleven feet. All this time the land had been sinking. The sea now surrounded the pillars, which finally sank nine feet more; thus half the height was above the water, and of that which was beneath the surface, eleven feet was embedded, and nine exposed to the water; in this space the pillars were perceptibly perforated by a bivalve "Lithodomus." Thus if we include the lower pavement, the land must have sunk 25 feet since the commencement of the Christian era. When the upheaval began, it has not been observed, but it was known to be in progress in 1530, and in 1838 the pavement was again above the sea level. The downward movement has again commenced, at the rate of about one inch annually. Here then we have evidence of a structure which has undergone a subsidence and an upheaval of at least 20 feet, and still stands to attest the quietness and regularity of the movement. Although this subject of the alteration of level of the earth's surface is a difficult one to prove, from the peculiar circumstances of the case, yet, we may safely infer that this oscillation is more general than is commonly supposed; and may fairly be brought to account for the depression and upheaval necessary for bringing the aqueous rocks to form the surface of continents. For the reader may remember that the rocks which underlie a great part of the dry land, as well as most of those found in the formation of lofty mountains, furnish unmistakable evidence of their having grown beneath the water. This too will partly account for the fact of by far the greatest part of the fossilized plants and animals which have been found being of aquatic origin. In no other part of the world, we believe, has the subject of geology been more pursued than in the island of Britain, and as this island is so extremely small in proportion to the great extent of the globe, and as only small portions of it too have been geologically examined, it is the more surprising that such a great number of fossil animals and plants, and other interesting fossils, have been discovered there. We would add a list of the fossil plants and animals which have until recently been discovered in all parts of the globe to show the proportion which they bear in respect to kind to those now existing, but for the fact that these proportions are continually varying by means of the discovery of more fossils, and some new living species.

To throw a little light upon this subject, however, we may give some idea, as comparative, of the fossil animals with those now existing. The animal kingdom is subdivided so far as is known into about 120 orders. Now, how many of these orders are extinct? that is, how many of these orders of animals have lived in former ages, but have at present no living representatives? Among the mammalia

and birds there are none extinct. But when we come to reptiles out of the eight orders that are made out as belonging to the past and present, one half are extinct. The pterodactyle, ichthiosaurus, and plesiosaurus give some idea of those gigantic animals. Of the *Amphibia* there is one extinct order, the Labyrinthodonts, a large salamander-like beast. No order of fishes is known to be extinct; all the fishes found in the strata examined are identified and placed in one of the existing orders. There is not known to be a single order of insects extinct. There are only two orders extinct among the *Crustacea*. There is not known to be an extinct order of the parasitic and other worms, but there are two or three extinct orders of the class Echinodermata. Out of all the orders of the *Celenterata* and *Radiata*, only one is extinct, the Rugose Corals, so that summing up all the orders of animals, not more than about ten per cent. are without representatives now existing; and the proportion of extinct orders of plants is much smaller. This fact is astonishing considering the enormous lapse of time which these animals and plants represent. From the Cambrian formation to the present, there is reckoned by some geologists to have intervened a period of not less than sixty millions of years; other geologists, however, consider that estimate as too small.

Geologists remark that the remains of man are mostly found in the alluvial deposits of rivers and lakes. These deposits contain also skeletons of land animals together with fresh water shells, intermixed with silt and vegetable drift carried down by the rivers. The reason they are found in such places rather than in others is, first, that man must have always occupied the regions of the land as a residence; and the remains of human beings found in such places are doubtless for the most part of those who have been drowned in the waters of the lakes, or in the rivers, and washed down with the debris which rivers usually carry to their mouths. We have ourselves seen in an alluvial deposit in the State of New York, a fossilized man of such dimensions that, when living, he must have measured about ten feet in height, and was made in proportion. We had the opportunity of closely examining this fossil and it appeared to have once been a noble specimen of human kind, and not to have belonged to any of the tribes now inhabiting this continent. Its antiquity, as indicated by its appearance, and the place in which it was found, must have been considerable. Secondly, according to the evidence of geology and history, mankind has always been accustomed to dispose of his dead by burial and otherwise. But, besides the remains of human beings which have been discovered, many indications of their existence are brought to light in the form of warlike instruments, etc.

These are in the shape of knives, arrow and spear heads, hatchets and hammers, which indicate that the state of civilization of those using them was not high. The material and workmanship of these tools are considered by geologists to have marked the successive periods and the successive stages of civilization through which man has passed. But it is evident that in any period of the past, as at present, some tribes and nations may have been more civilized and ingenious than others, and that while one tribe used instruments of one material, and of good workmanship, another may have used instruments of another material and of better workmanship. There are found instruments of stone, of bronze (an alloy of tin and copper) and of iron; and the ages in which they are said to have been used are termed respectively the stone age, the bronze age, and the iron age. In the stone instruments there is a variety displayed indicating a less or a greater degree of ingenuity or tact in their making. Some of them are made of flint seemingly chipped into the required shape by hand. The regularity and proportion displayed in these arrow and spear heads are often remarkable. Although it may appear strange, it is said that the flint chips more easily when chipped with another flint, than if an iron tool be used; so that we need not be surprised at the clever specimens of stone handicraft, preserved for us in these deposits, and formed by men who, like the North American Indians of the past, were not acquainted with the use of iron. Some of these flint instruments appear as if they had been subjected to a process of grinding, and consequently exhibit more skilful workmanship. An ancient people who fabricated these instruments lived in the Northern part of France, and in the South of Britain. In the river gravels of Abbeville and Amiens in France, M. Boucher de Perthes found in 1847 many specimens of their handicraft. These beds of gravel vary in their depth to the present bottom of the valley from 20 to 200 feet. This depth indicates the amount of scooping work the river has done since these ancient people occupied its banks. These tools are usually bleached by long exposure to the air, or they are stained with the same yellow tinge which pervades the gravel bank, and sometimes crystalline incrustations of carbonate of lime appear upon their surface. Their edges are blunted either by wear or by the rolling action of the water, and they are usually found at depths of from fifteen to twenty feet from the surface. The fact that the Somme river has worn away more than 200 feet of valley since the people of this stone age inhabited its banks may impress us with some notion of the time which has elapsed since that very remote period; yet the position in which similar instruments are found in the South of England, carries our

minds still further back into the past. On the tops of the hills in South Hampshire, and in the North of the Isle of Wight, masses of gravel are found. These detached beds are believed to be the remnants of a great deposit of drift resting upon the Eocene Tertiary Strata. In this gravel are blocks of sandstone, some twenty feet in circumference, and to account for their presence at some distance from their native beds geologists have recourse to the agency of the glaciers. It is in this gravel that numerous specimens of stone tools, precisely similar to those of the Somme valley, have been found. If the theory of the glacier agency with respect to these rocks be true (and it does not seem altogether improbable when we consider that glaciers of great extent exist in the Alpine districts in the centre of Europe at present), then, when these ancient people inhabited Britain it was amid the ice and snow of the Arctic regions, or, at least, in the proximity of glaciers and ice fields. And since the time of their existence the Southampton river, the Avon, and the Stour have begun their course and gradually worn for themselves their present valleys. And probably the Isle of Wight was then part of the mainland; whether or not the Strait of Dover then existed may be guessed or known. But not only have they passed away, but many of the animals then existing are now extinct. The bones of the mammoth, the woolly-haired rhinoceros, the reindeer and the Norwegian lemming, all are associated with the flint instruments. These animals have all an Arctic relation, and the two first have been known alive in historical times. The first of these is simply a large kind of elephant, and the lemming is of the rat species. In the valley of the Somme the hippopotamus and the musk-ox are also found, indicating a somewhat more genial climate. The reason why the remains of men are not in general found associated with these instruments, is, as will appear more clearly from information hereafter to be given, that mankind has always been accustomed to bury their dead in detached places, or to burn them.

For a long time geologists refused to entertain the idea that mankind was co-existing with the mammoth; but now all doubt upon this subject too has been removed, for even in the scanty researches thus far more than 3000 flint instruments belonging to the ancient stone age have been discovered in Europe. Throughout the whole of Scandinavia (Sweden and Norway), although quantities of flint instruments are found, none of them are of the rude stone type found in the South of England, and in France; but all are ground and better shaped. This may indicate that they were of a later age than the stone weapons, or of the same or even an earlier age, and made and used by a more ingenious and civilized race of men. The thought

will probably strike one, was not Scandinavia in these early times covered with ice, and how could it then be inhabited? An equal and an equally forcible consideration is this—that Denmark was certainly inhabited by the men of the stone period; and if this being in such close proximity to the Scandinavian Peninsula, was inhabited why should not the latter have been? Doubtless the Scandinavian geologists have given considerable attention to this subject and understand it.

Along the coasts of the Danish islands are mounds from three to ten feet high, and some of them as many as 1000 feet long. These mounds are termed *kitchen middens*, being found to contain some shells of mollusks, etc., upon which the people lived. Being in close proximity to their dwellings it is natural they should contain many remnants of their mode of life; burnt bones of the animals they cooked, their stone knives, spears, etc. Sometimes bone and horn instruments are found in great numbers. The animals with which they were associated are still living in Europe, excepting the beaver. The dog alone, however, seems to have been domesticated by them. These facts, and fragments of rude pottery that are found, go to prove them to have been partially civilized.

These ancient people have reminiscences of their existence preserved to us in peat-bogs, and in Denmark successive stages of civilization are observed. In the lower beds of peat, stone weapons occur side by side with the roots of the Scottish pine, a tree which has never been known in Denmark in historical times. Higher up in the same bronze instruments are found; but here the pine has become extinct and the oak takes its place. Still nearer the surface iron instruments are found; but during the bronze period the oak growth waxed and waned, the next the beech tree which now flourishes in Denmark occupied the country. Let the long periods which it must take for successive generations of forest trees to wear themselves out tell the years which measure these ages of stone, and bronze, and iron.

An interesting and singular repository of these ancient relics has lately been discovered in Switzerland. It seems that it was the custom of the ancient inhabitants of the Swiss valleys to construct their villages on piles, driven into the bottom of the lakes, where the water was not more than fifteen feet deep. No fewer than one hundred and fifty of these lake villages, have been already discovered. Being surrounded with water the inhabitants were secure from the attacks of wild beasts, and in some measure from their human enemies. By dredging in the ooze great numbers of articles have been found. Some villages are characterized as of the stone age, others of the bronze, and others again give evidence of having been inhabited by

people who used both the stone and bronze instruments. Among other things taken up from the villages characterized as of the stone age are charred corn, and bread. This proves that the people of that very ancient period cultivated corn. No corn has been discovered in the villages where the bronze instruments have been found, but the vessels occasionally bear the marks of the potter's wheel. Numerous animals were domesticated, and gold, amber, and glass were used for ornaments. From the size of the sword-handles and the bracelets it is concluded that the people denominated as of the stone age were smaller than the present inhabitants of Northern Europe.

With respect to the disposition made of the dead the evidence is as follows: During the age of the stone weapons the mode of burial seems to have been in rude coffins of undressed stone. The skull is remarkably round and small, and this type is now most nearly approached in the Laplander. It is suggested that he may be the descendant of the men of the stone age, his ancestors having followed the ice northward. During the age of the bronze weapons the fashion of burial changed; or, perhaps, we may say with equal propriety that the men characterized as of the bronze weapons disposed of their dead differently. No human remains understood to have belonged to that period have been found; they *burned their dead*. When the age of iron came they again resorted to sepulchral burial, and now the skull appears larger and longer. The floors of caves have proved the richest storehouses of human remains; but owing to the fact that the cave may have been used as a burial place in comparatively recent times, it does not necessarily follow that human remains lying side by side with the bones of extinct animals belonged to human beings that lived contemporaneously with these animals. Out of the numerous fragments of skeletons which from time to time have been brought forth from such places Professor Duncan concludes that the lower jaw found in the cave of La Nautelle, the skull from the Engis cave, and the jaw of the Grotto des Fées are "the only examples of human bones which can bear criticism, and which can be referred to the mammoth age."

As we may have before intimated, the stone, bronze and iron instruments may have been used by the same nations and tribes for long successive ages, and may indicate the advances they made in civilization and art, or may have been used contemporaneously by different tribes and nations of different or the same degrees of civilization and art. The finding of the stone, bronze, and iron in successive strata, as in Denmark or in any other place where a sufficiently extensive search had been made, might appear to substantiate the first supposition; but the finding of these different kinds of in-

struments in neighboring villages or in the same village, would indicate that the second supposition might be equally true. The Augustan age in Europe, characterized by a certain kind of arms and arts, may have been characterized by very different kinds of arms and arts in China, which it undoubtedly was. Also, the ages of the bow and arrow in Europe and Asia were different from the modern age of artillery; and the tribes of Indians or other tribes who use the bow and arrow contemporaneously with the use of artillery by their white neighbors, may differ somewhat in point of civilization and art from the whites; or there may be tribes on the earth who might be considered as equally advanced in many respects in regard to civilization with the whites who still use bows and arrows. And even neighboring as well as distant tribes in prehistoric times may have differed in like manner, doubtless did. Each nation had then its own language, and differed from its neighbor in arts and characteristics even more than the nations differ now. We are to remember that the facts here adduced as to the discovery of human remains or of instruments indicating the existence of human beings in those very ancient times refer to Europe alone, and only to a small portion of that. But we have ocular evidence in the numerous tumuli of the Western States of the existence of men on the American continent in past ages, men who as we have been informed by a man of sound judgment who had inspected some of the remains, and handled some of the limbs, averaged 10 to 12 feet high (some of them much higher) and were made in proportion. The fact evidences as strong as anything can that different races of men have existed on this continent in past ages and have passed away in succession; men, some of whom were in point of size to the men of the present day, white, black, or red, as the huge mammoth or mastodon would be to the elephant. The whole continent of America has been peopled in some of the past ages by these gigantic races. We have mentioned in another place the huge fossil man we inspected in Western New York, which was casually happened upon by a man digging a trench on his own farm. And we have been since told by a clergyman, who resides on the eastern side of Lake Erie, that he had reason to believe that such huge fossils are not uncommon in the district in which he lives; for that, when in Elgin county, in Canada, he handled a skull of one of these ancient giants, whose remains had been casually found in the neighborhood, and that when through curiosity to find how his head compared with it in size he inserted his head into the cavity of the mammoth skull, there was still more than enough of room left on each side for him to insert his two hands between the skull and his ears.

The whole continent of America presents innumerable evidences of an extinct civilization. These are of various kinds, including mounds, tumuli, fortifications of large proportions, gardens, wells, artificial meadows, ruins of towns and cities once wealthy and populous, which all, with many other monuments are to be found scattered throughout the continent, especially from the 48th or 50th parallel on the north to about the same latitude on the South of the Equator. The valleys of the Mississippi and the Ohio abound in ancient mounds, tumuli, extensive fortifications, and traces of wells, salt mines, and artificial meadows which speak unmistakeably of a long period of time during which a numerous and powerful people of settled agricultural habits had made such considerable progress in civilization as to require large temples for their religious worship and extensive fortifications to protect them from their enemies. On the banks of the Blue river, the Black river and the St. Charles, near the river Gila, and upon an alluvial soil which reposes upon basaltic rocks, the remains of ancient colonies are very numerous. Rows and piles of stones show the plan of houses, though nearly covered up by the accumulated soil of ages. Here is seen a ruined circular stone wall about 250 yards in circumference with an entrance on the eastern side, and containing in its centre the ruins of a dwelling in which no traces of wood exist; three quarters of a mile distant the soil is strewn with enormous remnants of spacious edifices which contained rooms fifteen feet square. In most of these, fragments of painted pottery have been found and traces of decaying cedar wood. These houses are surrounded by a rampart 300 yards in length. One writer observes in speaking of this locality: "Subterranean fires appear to have ruined all this country and converted it into a barren waste; the country may also have been deserted in consequence of volcanic convulsions spreading death and misery among the inhabitants." Judging from the walls, houses, and remains of pottery met at every step, all this region of country seems to have been very populous in past ages. In the Apache territory near the Rio Grande is a copper mine which shows distinct traces of ancient working. A little to the East of this an ancient fort of a square shape is erected with a tower at each corner. The walls are four feet thick and in a state of some preservation. The banks of the Rio Verde abound in ruins of stone dwellings and fortifications which appear to have belonged to a more civilized people than the Aztecs. They are found in the most fertile valleys, where traces of former cultivation and of small canals for artificial irrigation are yet visible. The firmly built walls of these dwellings are twenty and thirty yards long to thirty or forty-five feet high, and from four feet

thick at the base gradually taper to the top. The houses were four storied, with small openings for doors, windows, and loopholes for defence against outside attacks. Excavations around these majestic ruins have yielded abundant fragments of beautiful pottery, black, yellow, red, striped and scalloped and ornamented with brilliantly colored paintings. Of the ruins in New Mexico the most modern are the *pueblos* or stone dwellings; they comprised usually a main portion and two receding wings at right angles to the main part, from the extremities of which extended a circular wall enclosing a large yard or court. They had the appearance of an immense barracks, being of four stories high, each receding from the preceding one like a series of terraces rising one above another. The outside wall had no openings in the first or lower stories, and each story was reached from the court or yard by ladders which could be drawn up after the inmates, thus giving no opportunity for the enemy to enter. The minor details of these structures indicate much ingenuity and art. Some of them appear in the distance like splendid mosaic work, being constructed of stones of various colors. They are built of small flat slabs, in some cases of fine granite sandstone, a material never used in any of the modern monuments of Mexico; and the walls show no trace of cement, the intervals being neatly filled up with small colored pebbles incrusting in mortar made without lime. Remains of ancient towns are extremely numerous in the country of the Zunis, the Navagos, and Jemez. All these towns are so ancient that no Indian tradition makes any mention of them. Humboldt, speaking of these remains of the unknown past, in which may be included the ruins of populous cities possessed of much grandeur, the amazing signs of mechanical and architectural science which are manifest in the construction of the palaces of Tezcozincó, the temple of Xochicalco, and the colossal stone calendar of Mexico, says: "Certain it is that they are the work of a great people, of an intelligent nation, whose civilization was far superior to that of the actual tribes." These ancients seem to have possessed a knowledge of astronomy, as all their structures had either four entrances or four corners or towers answering to the four cardinal points. In the Casas Grandes are met numerous ruins, among which is a tumulus surrounded by an earthen wall 100 yards in circumference. A little from this is a large round terrace 100 yards by 70, supporting a pyramid 30 feet in height by 25 yards at its summit, commanding a view of a plain extending north, east and west, on the left bank of the Gila. The Pimas Indians have a legend concerning these ruins which runs thus: They pretend that these edifices were constructed by the son of the most beautiful woman that ever existed and who formerly

lived in the neighboring mountains. Her extreme beauty caused her to be beloved by a multitude of suitors; but she refused to marry; when they visited her they paid her tribute, and by means of this resource she provided for the people during times of famine without provisions ever failing. At length one day she fell asleep, and from a dew-drop descending and falling upon her bosom she conceived and gave birth to a son who built these houses and many others to the north and south-west. Among all these ruins are found beads and painted pottery, and perforated shells which antiquarians believe were used as coins or ornaments.

The valleys of the Ohio and Mississippi are rich in monuments of various kinds, dating from a period long anterior to the historical era. In Ohio alone, the number of ancient mounds, wells, etc., has been estimated at ten thousand. The American mounds have been divided by antiquarians, as follows: altars, tombs, temples, and tumuli of no determinate character. Out of one hundred examined, sixty had served as temples, twenty as tombs, and the rest were places of observation, or mounds, the uses of which could not be determined. Their plans and construction differ according to the situation. In the vicinity of the great lakes, and in the States of Wisconsin, Iowa, Michigan, and the western territories, they are made of earth, of conical form or in the shape of animals, birds and reptiles, or even in that of man; appearing like immense *Bassi Relievi* carved out on the soil by the hands of giants. In the interior of these monuments relics of art have been discovered belonging to a very ancient period, and consisting of personal ornaments, domestic utensils, and articles connected with religious worship, made of different metals and of *Pietra dura*, also polished stone and copper implements.

In the Ohio valley these earthworks are larger, more numerous, and of a more regular construction, in many instances surrounded by earthworks or strong walls; and give the best indication, from their number and style, of the greatness, or at least the multitude and superiority of the populations by which they were constructed. Advancing southward these antiquities are remarkable for the great regularity of their structure and their extraordinary size, and in these southern parts only have traces of brickwork been detected in their construction. In Florida and Texas these mounds are composed of several stories, somewhat resembling a Mexican *Teocallis* in their pyramidal form, dimensions, lofty passages, spacious terraces, and long avenues; they are often surrounded by smaller ones placed at regular intervals, some with paths winding round them from the

base to the summit ; others have gigantic steps, like slips in European fortifications.

Enclosures are rare in Florida, but those of a military character have been discovered in the Carolinas. Of the courts or amphitheatres that existed in the far South, the purpose seems to have been that of places for public amusement, as in the amphitheatres at Rome. The tetragonal terraces are apparently foundations for elevated fortifications, while the pyramidal hillocks are supposed to have served as observatories commanding a view of a wide extent of country. In Florida, frequent vestiges of extensive roads are met with, some running in a straight line for sixty to seventy-five miles. These highways were elevated above the surrounding plains, and appear to have led to the great centres of population, traces of which still exist. After traversing ruins of towns and villages they terminated at the foot of one of those artificial *teocalli*, or high dwellings of the chiefs. Few American curiosities are more striking to the imagination than these great roads, and the magnificent scale on which they were constructed brings to the mind the great roads made by the Roman government through the provinces of the empire. The elevated structures, or mounds of Florida, were usually square-shaped, sloping on one side to the road, or reached by a series of wide steps leading to the summit of the monument. The Indian population, whom Columbus found here, had no knowledge of the origin or uses of these structures, which were covered equally with the surrounding country by forests of gigantic growth. We might mention also the immense gardens, of unknown origin, found scattered over various parts of the American continent, whose size and state of preservation has produced, in the minds of observers, much astonishment. This perfect preservation is thought to be owing to the thick coats of prairie grass, which is so dense and abundant as to form a compact vegetable coating on the surface of the soil. This enables all their sinuosities to be easily traced, and has prevented their surface being overgrown with forest, as obtains in other ruins. They are square, or semi-circular, and are divided in parallel lines so as to form a series of ridges or beds, two or three yards in width, and are separated from each other by a number of very narrow paths. One of them is described by Domeneck, as above eight miles in extent. No light has been thrown upon the nature of the produce of these extensive fields laid out with so much regularity. The finest and best preserved have been found in Indiana, Michigan, the Western territories and Texas. Besides these gardens, artificial meadows, many of which were found situated on the borders of wood land or in the midst of forests, were also cultivated by the agricultural population which

inhabited the western world previous to the tribes now existing. From the nature of the country, the configuration of the surface, as well as the agricultural implements of stone and brass found in those meadows, it is believed that in remote times these regions were covered with trees which must have been burned or torn up to make room for pasturage, etc., in the vicinity of human habitations. There are many traces which make it appear probable that the ancient inhabitants of the country worked the salt water springs in order to procure salt. These traces appear in Illinois, where, in a salt mine, there existed an excavation one hundred and thirty-five yards in circumference, in the middle of which a great pit had been dug at some unknown period. A conduit also existed by which it is supposed the water was drained off. In Ohio the salt mines give evidence of having been worked, the ancient remains of vases used in the evaporation of water having been found near the mines. In the saltpetre cave of Missouri hammers and axes similar to those found in the tumuli have been discovered. In the Lake Superior region are copper mines which bear unmistakeable traces of ancient mining. It appears that the ancients made use of tools of tempered copper, specimens of which have been found in the mines, as also evidences of the use of fire. The marks of such tools are traceable on the native copper.

Fortifications of a singularly strategical character and of immense proportions, have been found existing in the vicinity of the Ohio and Mississippi rivers. With reference to these it has been said that, "of all the great works left by the ancient American nations, none are more extraordinary or more worthy of study than those colossal fortifications and vast entrenched camps protecting and surrounding spaces so very considerable that of necessity, they must have been the work of a large population." The epoch at which these were constructed is, of course, quite unknown, but it is evident that they must have been coeval with the most ancient mounds or tumuli, since they are often placed within, or in the immediate neighborhood of, the fortifications, and in many cases form part of the general plan of defence.

These fortifications are found to consist sometimes of earthworks thrown up in the form of an extensive entrenched camp, or in the stone walls which have been thrown across peninsulas formed by the conflux of two rivers, and around the declivities of elevated terraces; while in all cases it is observable that a careful choice had been made of the most suitable position, of which every advantage has been taken to construct defensive fortifications on a surprisingly gigantic scale. On the delta formed between the Raccoon and Newark rivers

in the county of Licking, Ohio, there exists an elevated table-land about 35 feet in height upon which are remains of military constructions of great extent. On the west side of the platform stood an octagonal fort enclosing an area of about forty acres, having stone walls of solid masonry about nine feet in height, and the same in width at the base, each protected by a tumulus placed in the interior in front of the entrance. Two parallel walls lead to another circular fort at the southwest of the first, covering a space of 22 acres; further south is an elevated hillock or observatory which commands a view of the whole position, beneath which a secret passage leads to the opposite side of the river. A third fort of a circular form stands more to the right, enclosing about 26 acres; there was an interior ditch in this, out of which earth had been taken to assist in the formation of a wall, which ranged from 25 to 30 feet high. Two other parallel walls run towards the north, gradually converging to another fort of quadrangular form, enclosing an extent of about twenty acres. These four different forts are connected by rather low walls, and in the centre of the enclosed area is a shallow pond covering 150 to 200 acres, supposed to be artificial, and to have been required to afford water to the people and animals inhabiting the place; towers of observation placed at each of the salient points complete the works at this point. At Marietta, near the mouth of the Muskingum, some extraordinary ruins exist, among which are two square forts, the largest covering forty acres; these have earth walls from three to six feet high, and widest at the base; sixteen openings exist at regular intervals; at one side is a covered way formed by walls which are said to be 21 feet high, and 120 feet in length leading down to the river by a gentle slope. On the valley of the Paint Creek, near Chillicothe, is to be seen one of the most interesting of these fortifications; it is situated on a hill 300 feet high, and 130 acres in extent. The ascent is very steep and is accessible only on one side; a stone wall extends round this plateau of elevated ground. It is said that no engineer could have selected a more strategical position. On the little Miami and its tributaries, and in Ohio, several of these strongholds are said to have existed, in which the walls were disposed in a parallel manner. But enough has been said to show that the strongholds erected by these ancients were not of the meaner sort,—the earthworks seemed to be possessed of the greatest durability: for they have been protected by a growth of forest or thick grass, while the stone structures have tumbled in most cases to a mass of ruins only intelligible to the penetrating glance of the antiquarian. The Indians know nothing about the origin of these structures, nor about the people by whom they were erected: but they hold them

in traditional veneration. The tumuli are massive and pyramidal in form and some contain a vault within which are laid the remains of the dead; these vaults are usually built of stones placed one above another, without any cement, sometimes of wood, or of both combined. The mounds are of various dimensions, from three to ninety feet in height, and from 100 to 700 feet in circumference at the base. In the top there exist altars of baked clay or stone in the shape of large basins, varying from 19 inches to 17 yards in length; but the average is from 2 to 3 yards. A number of these were examined by Messrs. Squire and Davis and were usually found to contain ashes and remains of calcined human bones, with sometimes a few ornaments; this leads to the belief that the ancient Americans sometimes burned their dead. In the larger burial mounds the vaulted chamber usually contains a raised pedestal or altar, upon which is laid the human remains. These skeletons are ordinarily covered with sheets of mica, and carefully placed around them are found ornaments and utensils of various descriptions. One was discovered in Utah in which a polished silver breast-plate lay upon the skeleton; at each side of his head lay what appeared to have been two tapers extending upwards, while between the feet was found an earthen vessel of remote antiquity. Some of the vaults have a stone pavement floor while others are vaulted and floored with what appears to have been a species of brick or fire clay. In the Southern States, funeral urns have often been found within tumuli of this kind; also beds of charcoal, from which it is inferred that fire was used in their funeral rites. In these monuments also have been discovered ornaments of silver, brass, stone or bone, and ornamental beads made of shells; also pieces of silex, quartz, garnet, and obsidian, points of arrows, copper tools, marine shells, sculptures of human heads or of different animals, fragments of beautiful pottery, ornamented with brilliantly colored paintings of butterflies, quadrupeds and other things, indicating a knowledge of art.

Very valuable discoveries of this kind have been made in New Granada, where arms, idols, and medals were found enclosed in tombs of people whose successors have disappeared for many centuries, and whose enormous wealth is reported by tradition. The archæologists of Panama declare these works of art to belong to very remote antiquity, and consider them to possess characteristics of both Chinese and Egyptian art.

Domenech describes enclosures made of earth of about 300 yards in circumference and having but one entrance, situated on low flats of circular, elliptical, or quadrangular form, but in all cases of regular shape. Aside from these there are a multitude of small circles about

fifty yards in circumference, near which are grouped mounds that appear to have served as altars. The large circles extend over a surface of fifty acres, and are connected with rectangular enclosures by means of broad avenues. These walls are all made of earth. The religious feelings which actuated the authors of these immense structures, it is thought, can alone account for their erection. The Abbé Domenech, writes of them in these words: "If religion were out of the question it would be difficult to account for the object of works like those of Newark, which extend with their avenues over a space of more than four square miles, and to which only the great temples of Abury and Stonehenge in England, and Cornac in Brittany can be compared."

As to the probable age of these ruins we may observe that in the valleys of the Mississippi and Ohio; where the tumuli and ancient fortifications are found in the greatest numbers, trees of enormous dimensions have grown upon them, the age of which form the surest data on which to form a judgment as to the period when these different structures were abandoned. In 1787, Dr. Cutler found trees of immense size in the ruins of Marietta. Many of those cut down were hollow, but one in which decay had only just commenced showed 463 concentric rings: and as naturalists have conceded a year's growth to each ring this tree must have existed more than that number of years. On the ground lay huge decayed trunks measuring six yards in circumference; he then concludes that as these were not the first trees to grow on these ruins, they must have been abandoned nine hundred or a thousand years ago. Sir Charles Lyell relates that on the the same spot he, in company with Dr. Hildreth, in 1842, saw a tree, which, when sawn asunder, numbered eight hundred rings of annual growth. Gen. Harrison, President of the United States, in 1841, who was well skilled in wood-craft, remarked in a memoir upon this subject: "Several generations of trees must have lived and died before the mounds could have been overspread with that variety of species which they supported when the white man first beheld them, for the number and kind of trees were precisely the same as those which distinguished the surrounding forest." "We may be sure," he observes, "that no trees were allowed to grow so long as the earthen works were in use, and when they were forsaken, the ground, like all newly cleared land in Ohio, would for a time be monopolized by one or two species of trees, as the white poplar, the hickory, the yellow locust, and the black and white walnut. When these had died out, one after another, they would, in many cases, be succeeded (by virtue of the law which makes rotation in crops profitable in agriculture) by other kinds, till at last, after a great number of centuries, several

thousand years perhaps, that remarkable diversity of species characteristic of North America, and far exceeding what is seen in European forests, would be established." Taking this in connection with the opinion of a celebrated naturalist, who assumes that the oak is five hundred years in growing, remains five hundred years in *statu quo*, and is another five hundred years in decaying, we get some idea of the great antiquity of the American tumuli on which enormous oaks are found growing amid the remains of other oaks reduced to dust by extreme old age.

Hieroglyphic inscriptions have also been discovered from time to time in the States of Georgia, Kentucky, Minnesota, Ohio, Connecticut and Rhode Island, while some, remarkably well-preserved, have been found in the islands of Lake Erie. The red pipe-stone quarries of the meadow hillocks in the Western States conceal numbers, while others are met with in New Mexico. The most important and significant of these is that of Dighton rock. This rock is situated at the East of the mouth of the Taunton river in Manchuctka; the width of the rock is about forty-four feet, and the height in use about five feet; the surface is polished, either by water or by the hand of man. It was for a long time covered with moss, *detritus* and dirt, so that the inscription was not noticed until the middle of the last century, when it became a subject of much interest and scientific discussion. The characters entering into the composition of this inscription are decided to be hieroglyphic, kyriologic, and symbolical, and the strokes, roughly sculptured, appear to have been cut in the stone with a cylindrical instrument, the depth of the incision being about two lines. It has been attributed by M. Mathieu, a French writer, to the Atlantides, about the year of the world 1902; and Messrs. Yates and Moulton, in their History of New York, say it is of Phœnician origin. An inscription of much interest was also discovered in Grave Creek tumuli in Western Virginia. It was found buried with a skeleton in a mound containing two vaults; it is composed of twenty-two characters in three lines with a cross and a mask engraved on a dark, hard stone of an elliptic shape, about two and a half inches long, two inches wide, and about five lines thick.

Learned men who have examined this inscription most carefully, neither agree as to its origin nor as to the nature of its characters, of which four, it was thought, had a resemblance to the Etruscan signs, four to the Thugga (African), five to the ancient Runic in Scandinavia, six to the Touarick, seven to the old characters found in Ireland, ten to the Phœnician, and fifteen to the Celtiberian, several resembling more than one kind of character. The divided state of opinion

as to the relic only proves the uncertainty of its meaning, and causes one writer to ask the questions concerning it: Is it a sign, a motto, an ornament, or an historical remembrance?

There is another circumstance which is worthy of mention and is thought to be of great historical significance among the evidences of past civilization which are found to exist on this continent, namely, the marks of "fountain worship." The ancient peoples of Mexico and Peru have left traces, not only of the Phallic worship and its accompaniments, but also of that ancient material worship that believed the spiritual essences of things to be manifested in the expressions of life around them. Deity was perceived everywhere, and in everything, and thus they worshipped the sun, the moon (which they supposed controlled the weather), the stars, the earth (which they call their mother, the sun being their father), the rivers and fountains. The Zunis, above all, not using artificial means to irrigate their fields, and whose crops, therefore, depended entirely upon the rain that fell, believe to this day if they neglect to make their annual offerings to the spirit of the fountains their harvests will be destroyed by drought. Thus in Mexico, Ireland, Scotland, as in ancient Carthage, Persia, Chaldæa, India, China, and Arabia, holy wells are held in great reverence and veneration by the inhabitants, who repair to them every year to make their offerings to the spirit of the springs. In the country of the Zuni one of these is still found; it is seven or eight yards in circumference, and surrounded by a low, circular wall. Once a year the water is withdrawn, when offerings of varnished pottery are placed upon the wall, there to remain until they fall by accident or time; hence there are to be seen here specimens of pottery of great antiquity. A tradition obtains among them that any one attempting to steal one of these offerings would be punished by instantaneous destruction. The worship of wells was practised in the East from times of the greatest antiquity, not only by the worshippers of Baal, by the Scythians, and their descendants, but also by the Chinese, Hindoos, Moors, Persians, Arabians, Egyptians, Jews, and Celts of Ireland and Scotland, where these objects of the profound veneration of the Celtic people were usually situated in the most picturesque spots, on the slopes of hills and venerable oaks, amidst rocks covered with heaths, in retreats difficult of access, and, above all, in the vicinity of an ancient oak or upright unhewn stone, and in dark and mysterious solitudes, where the breezes and the brooks murmur incessantly, and where the voice of man finds a faithful echo always ready to make nature resound with the songs and praises inspired by the piety of the people. In England, it

is said, the Druids practised this worship, and under the reign of Canute and Edgar edicts were promulgated against those who venerated these sacred wells; while in the Scandinavian manuscript, it is related that in the tenth century, a schism arose among the Americans, some of whom were accused of despising the sacred well of Vagarscriebat. That a worship so ancient and so general in the Eastern Hemisphere as that of the fountains and wells should have been found to exist in the Western Hemisphere, may appear to be a mark of no small significance. In those times, there were people who believed that spirits presided over these fountains and rivers; that these spirits were invisible, and hovered around them, and received with pleasure the offerings made to them by mankind either as thanksgiving or propitiation.

Certain idols, shells, pottery and ancient mummies, have been found in the mounds and caves of Tennessee, which are thought by some writers to point to an Asiatic origin. In reference to these remains, the Abbé Domenech writes: "A knowledge of conchology is by no means unimportant in the study of the origin of the first inhabitants of North America, since it appears that they employed large marine shells, for their personal use, and for their sacrifices." The tumuli found in the valleys of the great rivers and the ruins of ancient fortifications contain a great number of these shells, which have formed the subject of long discussions among ethnographers, who are not agreed as to the locality of their origin. The most curious, perhaps, of the idols which have been found in these ruins have been found in the State of Tennessee. One of these was found enclosed in a small shell of the species *Cassis Flammea* which is of tropical origin, the others are without shells and either seated on their heels or kneeling, the hands being placed upon the thighs or abdomen. They are naked, and represent both sexes; the largest are about 14 inches in height; they are cut in stone common to the country. One of the professors of the University of Tennessee expressed the opinion that all these idols were representations of the ancient Phallic worship and were similar to those exposed in the temples of Eleusis.

The existence of American mummies, swathed in the veritable manner of the ancient Egyptian mummies, excited considerable surprise and comment at the time of their discovery. They happened to be discovered only in the neighborhood of large rivers, where vessels could easily approach; they evidently belong to a race anterior to the red Indian; and from their discovery, some writers agree that the ancient inhabitants of the continent were of Egyptian origin, or at least came from the shores of the Mediterranean, while

Dr. Mitchell endeavored to prove that the ancient inhabitants of America were of Malay origin, and resembled the natives of the islands of the Polynesia and Australasia. He founded this opinion on the resemblance of the cloth in which these mummies were enveloped to that brought from the Sandwich and Fiji Islands, which is similarly made of fine cord doubled and twisted by hand; and again on the fact that feather mantles are applied to a similar use by the the islanders of the Southern Ocean. It may, however, appear strange to men of sober reflection that our modern ethnographers are not content to allow the ancient inhabitants of this continent to have had an American origin without wearying themselves with investigating an origin for them on other parts of the earth's surface.

The mummies were found in great numbers in the Mammoth Cave near Louisville in Kentucky. This cave contains a large quantity of nitre, and the preservation of these mummies is attributed to its presence. Domenech describes one of these, that was found nine feet below the surface of the soil; it was placed between two large stones and covered by a flat slab; the knees were drawn up to the chest, the arms crossed, and the hands folded the one over the other at the height of the chin. The hands, nails, ears, hair, teeth, and all the features were in a state of perfect preservation. The skin resembled leather of a yellowish color, and no traces of an opening in the body could be detected. Though this mummy was of a person six feet in height, it was so dried up that it did not weigh more than fourteen pounds. This body was not surrounded either by bandages or by any bituminous or aromatic substance, but was wrapped in four coverings. The first or interior one was made of fine cord doubled and twisted in a peculiar manner, and of large feathers interwoven with great art; the second wrapping was of the same stuff, but without feathers; the third consisted of a deer skin without hair; and the fourth and external covering of another deer skin, but with hair. The bodies of a man and woman found in a saltpetre cave in Warren County, Tennessee, are also described by the same writer; these were wrapped in deer skins, and in a cloth made of the fibres of the bark of trees and ornamented with feathers; while in the hand of the female was a fan composed of turkey's feathers, and made to open and shut at pleasure. These relics of past ages have greatly occupied the attention of American antiquarians, but the race to which they belong, evidently anterior to the Indian, is not decided.

Naturalists have expressed the opinion that the horse is not a native of the American continent; according to Linnæus, it is a native of Europe and the East, while Goldsmith makes it to be a

native of Africa; and yet, when the European first set foot upon this continent, vast herds of these animals in a wild state were found roaming at large over the immense prairies of the West. It has been suggested that these may be the descendants of the domesticated animals, once used by the ancient agricultural population who were the former cultivators of the soil. There are also herds of sheep in the north of Mexico apparently quite wild. Of these are two varieties, one called the "Rocky Mountain Sheep," found inhabiting the elevated regions between the 48th and 60th parallels of north latitude, and near the head waters of the Columbia, the country at the sources of the Marais, the Saskatchewan and Arthabaska rivers, but less numerous on the eastern than on the western slope of the Rocky Mountains; and a second bearing the name of the American Argali or *Ovis Pygargus*, believed by some to be identical with the *Ovis Ammon* of Central Asia, Siberia, and Kamschatka. The wild *bison*, of which the domestic ox is a variety, are also found in large herds, and these, together with immense flocks of wild *turkeys*, luxuriate at perfect liberty upon the rich pastures of the great prairies of the West.

The *turkey* was supposed by some to be a native of Peru, South America, by others to be a native of the East Indies, or Japan, or probably some of the islands of the Indian Ocean, whence it was brought to America by the ancient Malayan maritime adventurers. We see, however, no good reason why naturalists should seek an origin outside of America for any tribe of animals found on this continent, when the modern white men first set foot on it; still not attempting to deny that some of these tribes might have had an origin, if we may speak of an origin in some other part of the globe, for it cannot be said that there was no intercourse of men between these continents in the ages preceding the discovery of America by the modern Europeans, which undoubtedly there was.

Tropical plants and varieties of grasses common to other countries are found growing in the Western sections of the continent; among these are the maize and garden bean.

From the various relics which have been mentioned, and others to which we need not here refer, we gather that a great and powerful people, advanced in arts and agriculture, and acquainted with the use of metals, held sway over this continent prior to the red Indians. Ruins of ancient *pueblos*, remarkable for their construction and immense size, some of which were erected on the opposite sides of rivers, and connected by bridges, are scattered over the country, south of the great prairies of the West. The configuration of the surface, the existence of river beds where the water has long since ceased to flow, whose banks, once gay with a tropical verdure, plants,

As to the animals mentioned on this page see, for example, Articles "The Horse," "The Sheep," "The Turkey," etc., in Gould's "Naturalist's Library," and "Jardine's Library of Nat. History," vol. 23; we find the horse sculptured on the ancient American monuments, and 30 years ago there had been discovered in the United States alone 12 species of fossil horses.

flowers and trees, have now given place to deserts of sand, presenting everywhere a picture of desolation; so that Domenech and others who have explored these regions and written upon them, believe that, at some indefinite period of the past, this whole territory was densely populated by a settled agricultural people, but who by some great geological change, perhaps volcanic, taking place in the country, changing the soil from a rich and fertile country, well watered, into a dry, barren, sandy desert, were compelled to seek a settlement elsewhere.

Domenech thinks that the great centres of this ancient civilization were near the great lakes in Ohio, and in Mexico, and Peru, whither the natives repaired to have commercial interchange with each other. This he deduces from the discovery of mica sheets from the Alleghanies, shells from the Gulf of Mexico and Florida, and obsidian from the mountains of Mexico, and copper instruments, with specimens of ore, from Lake Superior, which are found buried, together with ornaments of silver, brass, stone and bronze, in the ancient mounds of Ohio, and whose origin and history seems as impenetrable as the night of ages. In the history of the ancient American races are recognized in order, by antiquarians, the age of rough stone implements, the age of polished stone implements, and the age of copper tools. The ages of brass and iron instruments and tools are later, and that in which we live.

Since there exists such multitudinous relics of past civilization on this continent, it becomes a matter of interest to enquire whether, among the ancient traditions of America, or the records and mythologies of the Old World, any traces can be discovered of an acquaintance with this continent by the people of the other hemisphere. Inquirers of the greatest care and intelligence believe that communication between the two continents did exist at a very remote period. Evidences of this they discover in the ruins to which we have referred, and in the traditions of ancient America, as well as in the traditions and myths of classical antiquity. The antiquities of Mexico and Central America reveal religious devices, symbols, and ideas almost identical with those found in all countries of the Old World where communities called Cushite formerly existed. They exhibit evidences of the worship of the heavenly bodies, with its usual orphic and phallic accompaniments. Humboldt, when visiting America, observed these remains of past civilization, and was convinced that communication between the two continents formerly existed. The Abbé Domenech, who traversed the desert wilds of America and Mexico, also produced two volumes as the results of his discoveries, which abounded with evidences of an extinct civiliza-

tion. Humboldt found evidences of it in the religious symbols, the hieroglyphics, the architecture, and the social customs, made manifest among the ruins, which he felt sure came from across the seas, and in his view the date of this communication was older than the present division of Asia into Chinese, Mongols, Tartars and Hindoos.*

The high state of agriculture, mechanical art, commerce, the profusion of gold and copper, and the religious views and domestic manners which were found to exist among the long since extinct Aztec and Zezcucon people found in possession of the Eastern Shores of Mexico by the rapacious Spaniards, are indicative of a long period of peaceful possession and prosperity in that country, during which time they had succeeded in surrounding themselves with every imaginable kind of luxury; and there are traces of a superior civilization even beyond the Aztecs. They possessed a system of numerals, and divided their year into 18 months of 20 days each, five complementary days being added, as by the Egyptians, to make up the full number of 365 days. They were also devoted to astrology, and their knowledge of astronomy is truly astonishing. They used the sun-dial to mark the day, which was divided into 16 parts, commencing at sunrise. An immense circular block of carved stone, disintegrated in the great square of Mexico, in 1790, has supplied the means of establishing some interesting facts in regard to ancient Mexican science. This colossal fragment, on which the calendar is engraved, shows that they had the means of determining the hours of the day with precision, the periods of the solstices and the equinoxes, and of the transit of the sun across the meridian of Mexico. It is hardly possible that a nation so far advanced as the Aztecs in mechanical science should not have made considerable progress in the mechanical arts. A degree of refinement is, indeed, shown by intellectual progress of any kind, requiring, as it does a certain cultivation of both useful and elegant art. Agriculture was in the same advanced state in Mexico as were the other arts of social life. Their chief productions consisted of beans, Indian corn or maize, the cacao, from which chocolate is derived, the vanilla, used for flavoring their food and drink. The gigantic stalks of the great staple, Indian corn, afforded them a saccharine matter which supplied the natives with sugar little inferior to that of the cane itself; but the most wonderful production of the soil was the great Mexican aloe, or Maquey tree, whose clustering pyramids of flowers, towering above their dark coronals of leaves, were seen sprinkled over

* See "Researches concerning the institutions and monuments of the ancient people of America."

many broad acres of the table-land. Its bruised leaves afforded a paste, from which they manufactured paper; its juice was fermented into an intoxicating beverage called *pulque*, of which they were excessively fond; with its leaves the more humble dwellings were thatched; thread, of which coarse stuffs were manufactured, and strong cords were made from its tough and twisted fibres; pins and needles were made from the thorns on the extremity of its leaves; and the root, when subjected to a process of cooking, was converted into a palatable and nutritious food; it furnished, in short, meat, drink, clothing and writing material to the Aztec. A large variety of plants, many of them of great medicinal virtue, have been introduced into Europe from these regions. The Mexican flowers, also, are of the most variegated and gaudy colors, and now form the greatest attraction of European greenhouses. They were well acquainted with the mineral as well as the vegetable treasures of their country. They drew silver, lead, and tin from the mines of Tasco; also copper from the mountains of Zacotollan, taken not only from the crude masses on the surface, but also from veins wrought in the solid rock, into which they opened extensive galleries. The gold which they found on the surface and gleaned from the beds of rivers they cast into bars, in which state, or in the form of dust, it made part of the regular tribute. Iron existed in the soil, but they knew nothing of its uses. They found a substitute in an alloy of tin and copper, and with tools made of this bronze they could cut not only metals, but it is said, with the aid of siliceous dust, the hardest substances, as basalt, porphyry, amethysts and emeralds. They fashioned these last, which were found very large, into many curious and fantastic forms. They also cast vessels of gold and silver, carving them with their metallic chisels in a very delicate manner. Some of the silver vases were so large that a man could not encircle them with his arms. They imitated with great nicety the figures of animals; and, what was extraordinary, could mix the metals in such a manner that the feathers of a bird or the scales of a fish should be alternately of gold and silver. They used another metal, made of obsidian, a transparent mineral, exceedingly hard, found in abundance in their mountains, which they manufactured into knives, razors, and serrated swords. It was said to take a keen edge, although it soon became blunted; and with it they wrought the various stones and alabasters used in the construction of their public works and principal buildings. These ancient Mexicans made utensils of earthenware for their ordinary purposes of domestic life. They made cups and vases of lacquered or painted wood, impervious to wet and gaudily colored. Their dyes were obtained both from mineral

and vegetable substances. Among these was the rich cochineal, the modern rival of the far famed Tyrian purple; with this they gave a brilliant color to the webs which were manufactured of every degree of fineness from the cotton plant, which grew in abundance in the southern parts of the country. They also employed the art of interweaving with these the delicate hair of rabbits and other animals, which made a cloth of great warmth, as well as beauty, and of a kind altogether peculiar to themselves; on this they often laid a rich embroidery of birds, flowers, or other fanciful devices.

But the art in which they most delighted was the plumage or feather work; and with this they could produce all the effect of a beautiful mosaic. The gorgeous plumage of the tropical birds, especially of the parrot tribe, afforded them every variety of color; and the fine down of the humming-bird, which revelled in swarms among the honeysuckle bowers of Mexico, supplied them with soft aerial tints, which gave an exquisite finish to the picture. The feathers, pasted on a fine cotton web, were wrought into dresses for the wealthy, hangings for apartments, and ornaments for the temples. The profusion in which gold existed in Mexico and Peru, and the estimation in which it was held by these ancients, was best seen in the manner in which it was used in the liberal decoration of their temples, "which" one writer says, "shone resplendent by reason of the abundance in which it was used," and for the adornment and magnificence of their princes. Their palaces, gardens, fountains, and temples exceeded those of every other portion of the country, a detailed account of which is given by Prescott in his reference to the golden age of Tezcuco. Translations into the English and Spanish languages have been made of ancient manuscripts found in Mexico by the Spaniards at the time of their conquest of that country, one especially contains the advice of an Aztec mother to her daughter on the occasion of her marriage, inculcating the precepts of monogamy, conjugal fidelity, the idea of a Supreme Being, to whom all are responsible, and who sees all our actions. This document also contains an admonition to the bride to persevere in the practice of those graces and virtues which had distinguished her ancestors; advice in fact altogether equal to what might be expected of a Christian mother at the present day. The Abbé Brasseur de Bourbourg shows that the symbols of phallic worship were described by Spanish writers at the time of their conquest; that they were frequent in the countries of Central America, abounding in Colhuacan, a city on the gulf of California, and at Panuco (the former was at one time a flourishing city, the capital of an important kingdom); here phallic institutions had existed from time immemorial. In the

temples at Panuco phallic symbols abounded, and also on the public monuments. These, with the serpent devices, the sun-worship, the remarkable knowledge of astronomy accompanying them, shows a system of religion of which the Abbé says: "Asia appears to have been its cradle, as that of the social institutions which it consecrated."

It is said that the traditions of the inhabitants of Mexico and Central America uniformly assert that the ancient American civilization came originally from the east "across the ocean." The Abbé de Bourbourg, speaking of the earliest civilization of the inhabitants of these countries, says: the native traditions generally attribute it to "bearded white men, who came across the ocean from the east." The history of Sahagun also states that, according to the traditions of the people of Yucatan, "the original civilizers came in ships from the east." Montezuma, it is said, related a similar tradition to the Spaniards. There were in Central America three classes of ancient inhabitants, first, the Chichimecs, who seem to have been the uncivilized aborigines of the country; the Colhuas, who were the first civilizers, and who were the "bearded white men" who came in the early times across the Atlantic, and who built Palenque and other cities, originated the oldest and finest monuments of the ancient civilization, and established the great kingdom of Kibalba celebrated in tradition and history; it comprised Guatemala, Chiapas, Yucatan, and probably other countries. The third class of inhabitants mentioned are the Toltecs, a powerful race, whom Humboldt, strangely enough, supposed to have derived their origin from the Huns, and who came much later as peaceable immigrants, but, uniting with the uncivilized Chichimecs, caused a civil war and acquired the ascendancy over the land.

Desiri Charmay, in speaking of the ruins of the ancient city of Mitla, points out the most ancient architecture, paintings, mosaics and artistic designs as being in the highest style, showing marvellous workmanship; while the later additions are in a much lower style, and seem to be the work of a people much less advanced in culture and skill than the original founders of the city. The most remarkable and finest monuments found in those countries are believed to belong to the remains of the ancient kingdom of Kibalba. Other traditions point to an existing acquaintance with the country among the Chinese and Malays. The Abbé de Bourbourg relates that there was a constant tradition among the people who dwelt upon the Pacific Coast that people from distant countries across the Pacific formerly came to trade at the ports of Coatulco and Pechugui, which belonged to the Kingdom of Tehautepec. Again the traditions of Peru tell

of people who came to that country by sea and landed on the Pacific Coast, thought probably to be the Malays of the great Malayan maritime empire that flourished in ancient days.

If we now turn to the ancient traditions, mythology, and records of the Eastern world, we shall find much that points directly to an acquaintance with the "Atlantic," or "continent beyond the sea," which either appears to refer to America or to be utterly meaningless, which latter opinion does not seem to be entertained by any antiquarians of the present day. In ancient mythology there is reference to a great continent beyond the Cronian Sea, meaning the Atlantic; and it was in the Atlantadis of Homer and Horace, beyond the western waters, that the ancient poets placed their Elysian fields.

Theopompus, a learned historian and celebrated orator who lived in the days of Alexander the Great, relates, in his work entitled "Thaumasias," a very ancient dialogue which took place between Midas, King of Phrygia, and Silenus, in which the latter is made to say: "There is a continent beyond the sea, the dimensions of which are immense, almost without limit, greater than Asia, Europe and Lybia (Africa) together, and so fertile that animals of a prodigious size are to be seen there, as likewise a race of men calling themselves Meropes, whose stature is much greater than that of ordinary men, and who attain to an extreme old age; that a great many large towns and cities were to be found on that continent, one of which contained above a million of inhabitants, and having different laws and customs from those of the people of Asia, Africa, and Europe; and, finally, that gold and silver were found very common over all the surface of that vast continent. Another writer relates that these Meropes were so persuaded that there existed no continent but their own that out of curiosity alone some of them crossed the ocean and visited the hyperboreans. Another ancient writer, Diodorus of Sicily, in his fifth book, chapter 11, has an important passage concerning this continent, which is historical, in which he affirms that some Phœnicians were cast upon the shores of an exceedingly fertile island situated opposite to Africa. The passage referred to reads as follows: Over against Africa lies a very great island in the vast ocean, many days' sail from Lybia westward. The soil is very fruitful, it is diversified with mountains and pleasant vales, and the towns are adorned with stately buildings. Its shores are indented with countless navigable rivers; its fields are well cultivated and dotted with delicious gardens and with plants and trees of every sort; finally he describes it as being the most beautiful country known, with inhabitants who live in spacious dwellings, possessing

abundance of every kind. In regard to this the Abbé Domenech says: The recital made by Diodorus exactly corresponds with that of the first Spaniards who landed in Mexico.

It is related of one Hanno, who lived before the foundation of Rome, that he made a voyage beyond the Pillars of Hercules (the straits of Gibraltar) and visited a strange coast, which he reached by keeping due west, after traversing the ocean for thirty days. The best authors suppose this coast to have been that of one of the West India islands, or of the mainland of America. Homer, Solon, and Horace speak of the Atlantides as being islands situated at a distance of ten thousand stadia (a stadium is $606\frac{1}{2}$ English feet) west of Europe and Africa. Aristotle speaks of an island placed beyond the Straits of Hercules, in these words: "It is said that the Carthaginians have discovered beyond the Pillars of Hercules a very fertile island, but which is without inhabitants, yet full of forests, navigable rivers, and abounding in fruit; it is estimated many days voyage from the mainland." Plutarch also has a passage quoted by Humboldt, in which mention is made in unmistakable terms of a great transatlantic continent, and of a mysterious stranger who came from that distant country to Carthage, about 300 B. C., where he lived many years. According to Cabrera the first Carthaginian emigration to this Western Continent took place during the first Punic war. According to Sandoval a succession of emigrations came from Ceylon, Java, and from Southern India to America, many centuries before Christopher Columbus. In support of this statement figures representing the god Boudha of Java, seated on a Siva's head, were found at Uxmal, in Yucatan. It is well established that a knowledge of the American continent existed in China and Japan long before the time of Columbus. M. de Guigies, relying upon the chronicles preserved in the Chinese work, *Pran Y tien*, attributes the Peruvian civilization to emigrations proceeding from China, from Japan, and the East Indies; recent investigations, it is thought, confirm this opinion. M. Paravey, in the year 1844, proved that the province of Fu-Sang, described in the Chinese annals, was nothing less than Mexico, known to them in the fifth century; and the Abbé de Bourbourg says, in his introduction to the *Popol-Vuh*: "It has been known to scholars nearly a century that the Chinese were acquainted with the American continent in the fifth century of our era; their ships visited it; they called it Fu-Sang, and said it was situated at the distance of 20,000 li (about 7000 miles) from Ta-Han.

J. Hanly, the Chinese interpreter at San Francisco, has lately written an essay upon this subject, in which he makes the following statements, drawn from Chinese historians and geographers: Four-

teen hundred years ago even America had been discovered by the Chinese, and described by them. They stated that land to be about 20,000 Chinese miles distant from China. About 500 years after the birth of Christ, Buddhist priests repaired thither and brought back the news that they had met with Buddhist idols and religious writings in the country already. Their descriptions in many respects resemble those of the Spaniards a thousand years after. They called the country "Fu-Sang," after a tree which grew there, the Maquey tree, whose leaves resemble those of the bamboo, whose bark the natives made clothes and paper out of, and whose fruit they ate. These particulars correspond remarkably with those given by the historian Prescott about the Maquey tree in Mexico. The accounts given by the Chinese and Spaniards, although a thousand years apart, agree in stating that the natives did not possess any iron, but only copper; that they made all their tools for working in stone and metals out of copper and tin; and that they, in comparison with the nations of Europe and Asia, thought but little of the worth of silver and gold. The religious customs and forms of worship presented the same characteristics to the Chinese fourteen hundred years ago. There is, moreover, said to be a remarkable resemblance between the religion of the Aztecs and the Buddhism of the Chinese, as well as between the manners and customs of the Aztecs and those of the people of China. It is, however, remarkable, and may be thought confirmatory of the idea of emigration from China to America, at some remote period, that at the time that America was discovered by the Spaniards the Indian tribes on the coast of the Pacific opposite to China for the most part enjoyed a state of culture of ancient growth, while the inhabitants of the Atlantic coast were found in a state of original barbarism. The stone arrow-heads, lance-heads, hatchets and tomahawks found in Europe, India, Japan, and America, are so similar to each other that it is often impossible to distinguish them by their form. It is remarkable that everywhere except in America these weapons are believed by the common people to be thunder-bolts. They are called elf-bolts in Scotland; and Pliny speaks of them as *Ceraunia*; while in China and Japan the same origin is ascribed to them.

M. Leon de Rosny has ascertained that Fu-Sang is the topic of a curious notice in the great Japanese Encyclopedia, which enjoys the curious name of the "Wa-kan-san-tai-dron-ye." In that work it is said to be situated east of Japan, beyond the ocean, at the distance of about 20,000 Chinese miles from Ta-nan-kouek. Great stress is laid upon these records of the Chinese and Japanese, as they are

peoples that do not deal in myths, but in actual facts and historical events.

Let us now turn our attention to the Atlantic coasts, and enquire into the early communication with this continent by Europeans, prior to Columbus. Following the chronological order of events as they seem to have transpired here we first refer to the emigration of the Ires, or people from Ireland, who came to this continent by way of Iceland at rather uncertain epochs. The opinion of learned men, familiar with the antiquities of the Western world, is that, as in the most ancient records of Iceland the first inhabitants of that island are called "men come from the west by the sea," so we may conclude that Iceland was not colonized by people coming direct from Europe, but by Ires who had returned from America, who at an early period had been transplanted, and who returned from Virginia and the coast of Carolina (called Great Ireland) to settle in the island of Papar and the south-eastern coast of Iceland. In the ancient documents preserved in Iceland accounts are given of Christian Papas, or fathers who returned from Great Ireland on the West (America) to Iceland, to instruct the Icelanders in the principles of the Christian religion, about the year 800 A. D. Accounts are also given of persons who, having been cast away in ships, landed upon a western coast called "huitra manna land" or the land of the white men. These stories are considered as authentic, and as an important proof in favor of the prevailing opinion that at a very early period of the Christian era Irish colonies existed on the coast of the Carolinas and farther south. The Abbé Brasseur de Bourbourg, in a note to his translation of the Popol-Vuh, says on this matter there is an abundance of legends and traditions concerning the passage of the Irish into America, and their habitual communication with that continent many centuries before Columbus was heard of.

An Irish saint, named Vigile, who lived in the eighth century, was accused by Pope Zachary of having taught heresies on the subject of the antipodes. He at first wrote to the Pope in reply to the charge, but afterwards went to Rome to justify himself; and there he proved to the Pope that the Irish had long been accustomed to communicate with a transatlantic world. These facts are said to be preserved in the records of the Vatican. It is now an historical fact also that the Northmen, sailing from Iceland, not only discovered America in the tenth century, but also established colonies on the coast of New England, and preserved a communication with these colonies for two centuries. In 877, Gunbiorn, the Icelandish navigator, first saw the mountain sea-board of Greenland. It appears from the Scandinavian manuscript, in which are to be found the

accounts of the Normans' first voyages to America, that in 983 the celebrated Ari Marsson, while sailing southward, was cast by a storm upon the coast of this continent, which he called *Irland it Mikla*, or Great Ireland. In 986, Eric, surnamed the Red, established on these shores the first colony, composed of emigrants from Iceland. Afterwards, in 1124, a bishopric was instituted here called Garda, which existed for upwards of 300 years. In the year 1000, Lief, the eldest son of Eric the Red, sailed with thirty-five companions in search of new discoveries, when he discovered Newfoundland, and called it Litla Helluland; re-embarking he arrived in the country situated between Newfoundland and Canada, which he called Markland (now Labrador); pursuing his voyage farther south he landed on an agreeable coast, where he found an abundance of vines, which he called Vinland (now New England); here he made a settlement, which flourished for a length of time, and was visited in 1121 by the first bishop of Greenland, Eric Upu, of Irish origin, for the purpose of confirming the colonists of Vinland in the doctrines of Christianity. In the year 1002 another expedition under Thorwald, visited this coast and landed at Cape Cod, near Boston, where the leader was killed in an encounter with the Esquimaux. In the year 1006, Thorstein embarked on a similar expedition, but was unsuccessful. Thorfin, the most celebrated of the first explorers of America, landed in the year 1007 on the island called *Martha's Vineyard*, on the New England coast, and spent two winters in the bay of Mount Hope, close to Seconnet. From this time to the middle of the fourteenth century, very little can be ascertained concerning the Scandinavian colonies in America. In the twelfth century, Norwegian colonies existed in Greenland. In 1170 the Welsh prince, Madog, was quite certain of the existence of America, for, it is said, he sailed away westward, going south of Ireland, to find a land of refuge from the civil war which was raging among his countrymen. The Welsh annals inform us that he found the land he sought, and having made preparations for a settlement, he returned to Wales, secured a larger company, that filled ten ships, and then sailed away again and never returned. With reference to this Welsh colony we may state that in 1660, the Rev. Morgan Jones, a Welsh clergyman, seeking to go by land from South Carolina to Roanoke, was captured by the Tuscarora Indians. He declares that his life was spared because he spoke Welsh, which some of the Indians understood; that he was able to converse with them in Welsh; and that he remained with them four months preaching to them in Welsh. Dr. Williams, in his work on the "Story of Prince Madog's emigration," published in 1791, explained Mr. Jones' statement by assuming that the Welsh colony,

becoming weakened, had become incorporated with those Indians; and it is well known that in early colonial times the Tuscaroras were sometimes called "White Indians." It is known that the Northmen had colonies in New England long before Prince Madog's colony sailed for the Western continent; and one able writer says on this subject: "It is not so well known, but is nevertheless quite true, that they were preceded in Iceland by the Irish, and in voyages to America by the Irish and Basques; the latter, he says, "were adventurous fishermen, who were accustomed to visit the north-east coast of America from time immemorial." Thus it appears that sufficient evidence is afforded by ancient European records to warrant us in believing that America was not unknown to the ancients, and was comparatively well known to Europeans, in the early part of the Christian era, centuries before Columbus was heard of or the classical nations thought of changing their patristic geography.

The period of time which must have elapsed since the abandonment of the ancient monuments of America, of which we have spoken above, sufficient to allow of successive forests of so ancient a character to have lived and died upon them, taken together with other evidences of antiquity, lead us to suppose that the people by whom they were constructed lived and flourished in times perhaps long anterior to our historic ages; and this being the case we are told that those nations claim an antiquity which to Europeans appear almost fabulous. The Biblical chronologies extant in the present day appear to have been made out to show that the earth itself is scarce 6000 years old; but it should be remembered that the Scriptural writings furnish no data whereon to found any other than an uncertain and speculative chronology. When we look into the book of nature, which proclaims in such eloquent terms the wisdom and design and the progressive operations of the Creator, and which cannot lie, we find it tells us of events of such magnitude as to require prodigiously long periods of time for their accomplishment, making its moments appear eternities. What if in it we read that there are fossiliferous rocks which have been slowly raised ten thousand feet above the level of the sea, and that so late in the world's history as since the beginning of the tertiary period? What if it informs us that the peninsula of Florida, which is coraliferous, upon which are found monuments of ancient races, abandoned scores of centuries ago has not required less than 135,000 years in the process of its formation? Or if we discover from it that the great chasm, seven miles in length, through which the Niagara river flows from Goat Island to Queenstown Heights, required a period of over 30,000 years for its excavation; or that in certain alluvial beds numerous speci-

mens of the mastodon giganteus have been found on the shores of Lake Ontario, one at a great depth in Burlington Heights, Hamilton, and one in the old river bed on Goat Island; and that these individuals must have lived and flourished (says Sir Charles Lyell in his "Age of Deposits in North America"), previous to the gradual excavation of that deep, long chasm; for this ravine is not only postglacial but also posterior in date to the mastodon-bearing beds. Or, again, if the depression of the fern forests which now form the coal beds of Nova Scotia took place at the rate of four feet in a century, there was required a period of 375,000 years for their completion to their present depth. Or, as a forest can scarce produce more than two or three feet of vegetable soil in a thousand years, the dirt beds are the work of hundreds of centuries. Or, if it tells us that the delta of the Mississippi could only have been formed in many tens of thousands of years (estimated by Sir Charles Lyell at 100,000);* and that four successive cyprus forests lay buried in its depths and yet that it is only as a work of yesterday compared to the inland terraces of the Mississippi river; that skeletons have been disinhumed in this same delta to which Dr. Dowler assigns an antiquity of 40,000 years at least. Or, if, as Sir Charles Lyell says, it be admitted that the human remains discovered at Natchez, in connection with those of the Mastodon and Megalonyx, were found in their primitive bed, then a race of human beings must have occupied that country more than a thousand centuries ago; and if a thousand centuries ago, we may say why not tens of thousands of centuries; yea, a beginningless succession of centuries; for who will put a beginning to the human race other than it has now? To many who with difficulty shake off their patristic chronology such statements appear wonderful, and yet they are the deductions the most learned and profound geologists have drawn from their perusals of the book of nature. Who, then, will say that the poet was not partly right who penned that remarkable line: "Thou canst not find one spot whereon no city stood."

Before this continent was discovered by Columbus, Europeans generally did not know that it existed, with its races of men, its many languages, and its great natural wonders; but since that time, the progress of discovery has been rapid, and each continent and

* This refers to the whole area of the delta, and not only to what is now commonly understood as the delta, whose estimated period of formation is about 35,000 years.

For further light on the prehistoric researches, etc., the reader may consult Lyell's "Antiquity of Man;" Abbe Domenech's "Deserts of North America;" all the "Archæological researches" of E. G. Squier and Jno. L. Stephens; Humboldt's "Equinoctial Regions of the New Continent;" Prescott's "Conquest of Mexico" and "of Peru," etc.

island that has been discovered has exhibited its peculiar human inhabitants with their language, its flora and fauna. And while the Europeans and Asiatics, in their vain imagination, were setting up theory after theory as to the existence and nature of the Deity,—yea, and adding one deity to another in their assumed hierarchy of heaven; while they were expounding their doctrines of a literal creation of the earth in six literal days, of redemption, transubstantiation, total depravity, or predestination; while they were magnifying themselves in their own estimation by the invention of such systems, and the inculcation of such dogmas they were all but totally ignorant of the earth on which they lived; much more of the deity in the immensity of his nature, whom they pretended to know. Alexander and the Romans both made great mistakes when they sat down under the impression that they had conquered the world. There remained vast continents on the earth which they had never seen, never dreamed of; and there remained even in their own hemisphere a far greater extent of land than that which they had conquered, and which they had never explored. There remained the vast continent of Africa, with its numerous tribes and languages; and equally vast Eastern and Northern Asia and Northern Europe. The Hindoos and the Chinese have literature which goes back for tens of thousands of years; but our European system-makers would place the beginning of the existence of the earth and of men at less than six thousand years ago. The ancient Pelasgians, inhabitants of Eastern Europe, including Greece and Italy, called themselves Autochthons, that is, “offsprings of the earth.” This seems to have been their traditional belief of their origin. It was not, however, literally true, for no human being ever sprung from the earth as such. Nor did any real human being ever live, so far as we know, that was not produced by his own kind, male and female.

Mr. Darwin in his work on “The Descent of Man, and Selection in relation to Sex,” makes the following statement as to the origin and descent of man: “The most ancient progenitors in the kingdom of the vertebrata, at which we are able to obtain an obscure glance, apparently consisted of a group of marine animals, resembling the larvæ of existing *Ascidians*. These animals probably gave rise to a group of fishes, as lowly organized as the lancelet; and from these the Ganoids and other fishes like the *Lepidosiren* must have been developed. From such a fish a very small advance would carry us on to the amphibians. We have seen that birds and reptiles were once intimately connected together; and the *Monotremata* now, in a slight degree, connects animals with reptiles, but no one can at present say by what line of descent the three higher and related

classes, namely, mammals, birds and reptiles, were derived from either of the two lower vertebrate classes, namely, amphibians and fishes. In the class of mammals the steps are not difficult which led from the ancient Monotremata to the ancient Marsupials, and from these to the early progenitors of the placental mammals. We may thus ascend to the Lemuridæ; and the interval is not wide from these to the Simiadæ. The Simiadæ then branched off into two great stems, the New World and Old World Monkeys; and from the latter at a remote period, Man, the wonder and glory of the universe, proceeded. Thus, we have given to man a pedigree of prodigious length, but not, it may be said, of noble quality."

This is the theory which Mr. Darwin has propounded, or the conclusions to which he has come concerning man's origin. In it we have five noticeable stages (we may make as many more as we please *ad infinitum*) in the descent of man from an insignificant salt-water animal to his present state. The first stage consists of a group of marine animals resembling the larvæ of existing ascidians (Greek *ἀσχις* signifying a leather bottle, or wine skin, having two necks); called ascidians from the resemblance which these little animals bear to a two-necked jar or bottle. But according to the statement the progenitors of man only *resembled* the larvæ or spawn of these bottle-shaped animals. The second stage was probably a group of fishes. The third the Amphibians, which may represent the reptiles in general. The fourth we may take as the Simiadæ which will represent all the ape and monkey tribes as well as the Lemurs. And the fifth, the present stage, as Man.

The difficulty with us is, how any man, be his mental capacity and ability never so great, could command such a stretch of imagination as to conceive the human race, in all its colors and varieties, to have been derived through an infinite series of changes from the lowest species of salt-water animals. Fishes have come down to us through all the series of geological changes from the most ancient period of which geology has any knowledge of existing organic beings, and still they are fishes. And shall it not be allowed that man has also thus come down to us,—man in the most ancient periods as well as now,—since there is really no evidence to the contrary?

For our own part we do not consider that permanency in one form or descent through change of form makes the matter either better or worse for man,—makes him of itself, either a more or less respectable being, and while admitting that Mr. Darwin has displayed great ability and exercised great labor and pains in the fabrication and illustration of his theory,—yet in our opinion it remains a theory still. Men should consider that Word of Truth (see Gospel of John,

chapter i.) which represents the Logos, the son, or man in whom is exhibited the reason (and speech) as existing eternally with Deity. This appears to imply that the head or reason domination, which now characterizes man always existed whether or not always in connection with a body exactly of the human shape.

But this theory Mr. Darwin bases mainly upon geological discovery. He should bear in mind that the insignificant scratchings which geologists have done on exceedingly small spots of the earth's surface, amongst, for the most part, rocks of aquatic origin, are not by any means sufficient to base a theory upon which goes to assert **improbabilities with respect to any thing connected with the earth or to man.** What do men know about the tens of thousands of genera and species of aquatic plants and animals which may now live on the beds of the mighty oceans of the earth? What do they know, but that most of the fossilized aquatic animals which geologists have discovered are now represented by living species in the oceans and seas, salt water and fresh? Some species which existed in time past may have entirely passed away, and their place may be supplied by the multiplication of individuals in remaining species. But the discoveries of geology thus far do not afford any sufficient reason to believe that most of the species of plants and animals which existed in times past are not now represented in living species. These species may be modified in size, but they are of the same structure. Man of the past, of whatever size, and we know that his size has varied in different ages, is represented by man of the present. And so, we think, men will find with respect to most of the other species of animals, as well as of plants, if they only take time to make sufficient research, or if they ever *can* do it. By the time that even the vast continents of South and North America, Australia, and all the Islands of the Pacific and Indian Oceans, as well as Asia, Africa, and Europe, have been thoroughly explored by naturalists and geologists, then men will be better able to determine with respect to the land species of both plants and animals of the present and the past. It cannot be said with respect to geological discovery, as it is said with respect to the classes of things that what is true of one member of the class is true of the class in general. The geological discovery of Britain or France or of any other part of Europe may not be at all a fair representation of the geological discovery which may be made in Tartary, China, Central Africa, Brazil or Utah. Geologists know very well how that alteration is continually taking place in the earth's surface by elevation and depression; how that their researches hitherto have been among rocks chiefly of aquatic origin; how that many parts that were once dry land, inhabited by man and land ani-

mals, are now submerged far beneath the surface of the seas and oceans; and how that they could not answer a question, even approximately, with respect to the relations of past and present species until they would have explored not only all the dry land, but even the beds of the seas and oceans, a thing they cannot accomplish. Even in places on the land surface where fossil remains existed during long ages of the past there may remain no traces of any now, from the fact that they have disappeared by decomposition or some chemical process. But to say that one species of animals or of plants has ever been changed into another entirely different species or has been produced by two entirely different species is asserting a thing of which we have no experience or evidence. Experience is that hybrids do not propagate; they die out. And the appearance of different species of plants and animals in the successive geological strata, which geologists used to attribute to special acts of creation, are well accounted for by the *migration of species* and other causes. All the species of plants and animals have always and permanently sprung from their own seeds. The rose bush never sprung from the seed of the tamarack, the apple tree from the seed of the plum, the bean from the seed of wheat; nor did any one species of plants or animals ever spring from other than seeds of their own kind. Cross breeds of animals, such as mules, always exhibit characteristics unmistakably different from either of the species that entered into their production; and it is by the appearance and characteristics that the different species are determined. "I strongly imagine," says Prof. Huxley, in his Lectures to working men, "that if it were not for the peculiar appearance that fossilized animals have that you might readily walk through a museum which contains fossil remains mixed up with those of the present forms of life, and I doubt very much whether your uninstructed eyes would lead you to see any vast or wonderful difference between the two. If you looked closely you would notice in the first place a great many things very like animals with which you are acquainted now, you would see differences of shape and proportion, but on the whole a close similarity." With respect to Mr. Darwin's theory, we have but to add to what we have already said, that strange, indeed, is the course taken by some speculative minds! The great mass of mankind remain yet unenlightened; and when an individual arises who has become possessed of information which he wishes to impart to the rest, his object should be to instruct and enlighten them in the truth, and not to propound erroneous theories which will tend only to confuse the people's minds and render the truth more difficult to be attained.

Mr. Darwin's theory, which is that of some "evolutionists," if it means anything, assumes that all animal life (perhaps all organic life) may have branched out gradually from one primitive life cell, an assumption which by no means follows from all organic

Origin of Organic beings illustrated.

Nor will any knowledge whatever that we have with regard to the origin of species militate against anything we have said as to their probable permanent existence in the main as they now exist. It is a fact universally known that every living creature commences its existence in a form different from and simpler than that which it eventually attains. The apple-tree is a more complex thing than the rudimentary plant contained in the seed; the caterpillar is more complex than the egg; the butterfly than the caterpillar; and the series of changes which each of these beings runs through from its rudimentary state to its perfect condition is called its development. In the higher animals these changes are exceedingly complicated, but within the last half century they have become completely simplified by the labors of some eminent German scholars, as Von Baer and others; so that the successive stages of development which are exhibited by an animal, for example, a dog, are well known to the embryologist.

If we consider attentively the nature and the order of the stages of canine development it will serve as an illustration of the process in the higher animals generally.

The dog, like all animals except the very lowest (and it is thought that further enquiries may not improbably remove the apparent exception), commences its existence as an egg; as a body which is in every sense as much an egg as that of a hen, but does not possess that accumulation of nutritive matter which gives to the bird's egg its large size and domestic utility; and is without the shell which would not only be useless to an animal incubated within the body of its parent, but would separate it from the source of that nutriment which the young creature requires and which the minute egg of the mammal does not contain within it.

The egg of the dog is, in fact, a little spheroidal bag formed of a delicate transparent membrane called the *vitelline membrane*, and is about the 130th to the 125th of an inch in diameter. It contains a mass of nutritive matter, the *yelk*, within which is enclosed a second much more delicate spheroidal bag called the *germinal vesicle* (a). In this is situated a more solid round body termed the *germinal spot* (b). The egg or ovule is originally formed within a gland from which in due time it becomes detached and passes into the living chamber fitted for its maintenance and protection during the protracted process of gestation. Here placed in the required conditions this minute and apparently insignificant particle of living matter be-

beings commencing their existence in the same apparent form, the egg or cell, for the original identity is only in the appearance or form. (See pp. 202-210.) But, perhaps, the egg or primitive life-cell they have in mind is the globe of the earth.

comes animated by a new and mysterious activity. The germinal vesicle and spot cease to be discernible (their precise fate being one of the problems of embryology yet unsolved) but the yelk becomes

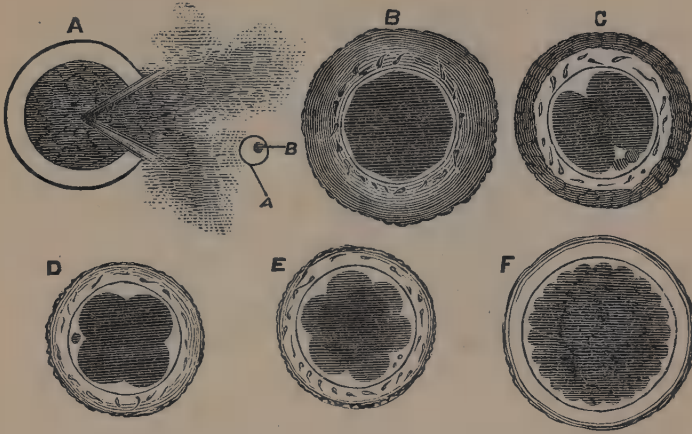


PLATE I. A, egg of the dog with *vitelline membrane* burst so as to give exit to the yelk, the germinal vesicle (a) and its included spot (b) B. C. D. E. F. successive changes of the yelk indicated in the text.

circumferentially indented as if an invisible knife had been drawn around it and thus appears divided into two hemispheres (C). By this repetition of the process in various planes these hemispheres become subdivided so that four segments are produced (D); and these in like manner divide and subdivide again until the whole yelk is converted into a mass of granules each of which consists of a minute spheroid of yelk substance inclosing a central particle called the *nucleus* (F).

Next the mass of organized cells, as they are technically termed, thus formed, acquire an orderly arrangement becoming converted into a hollow spheroid with double walls. Then upon one side of this spheroid appears a thickening and by and by in the centre of the area of thickening a straight shallow groove (Plate II. A) marks the central line of the edifice which is to be raised, or in other words indicates the position of the middle line of the body *canis incipientis*. The substance bounding the groove on each side next rises up into a fold, the rudiment of the side-wall of that long cavity which will eventually contain the spinal marrow and the brain, and in the floor of this chamber appears a solid cellular cord called the *notochord*. One end of the enclosed cavity dilates to form the head (Plate II. B), the other remains narrow and eventually becomes the tail; the side-walls of the body are fashioned out of the downward continuation of the walls of the groove, and from them by and by grow out

little buds which gradually assume the shape of limbs. Every part, every organ, is at first as it were sketched out in the rough, then

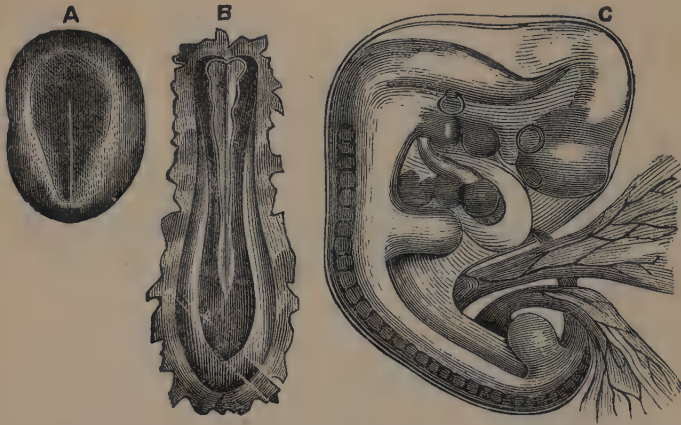


Plate II. A. Earliest rudiment of the Dog. B. rudiment farther advanced, showing the foundation of the head, tail, and vertebrate column. C. the very young puppy with attached ends of the yelk-sac, and allantois and invested in the amnion.

shaped more accurately and at the last receives the touches which stamp its final character. Thus at length the young dog assumes such a form as is shown in Plate II. C. In this condition it has a disproportionately large head as dissimilar to that of a dog as the bud-like limbs are unlike his legs.

A sac attached to the rudimentary intestine and termed the yelk-sac or *umbilical vesicle* contains the remains of the yelk which have not yet been applied to the nutriment and growth of the young animal. Two membranous bags intended to subserve respectively the protection and nutrition of the young creature have been developed from the skin and from the under and hinder surface of the body; the former called the amnion is a sac filled with fluid which invests the whole body of the embryo and serves as a sort of water-bed for it; the other termed the allantois grows out loaded with blood-vessels from the ventral region, and eventually applying itself to the walls of the cavity in which the developing organism is contained enables these vessels to become the channels by which the stream of nutriment required to supply the wants of the offspring is furnished to it by the parent.

The structure which is developed by the interlacement of the vessels of the offspring with those of the parent, and by means of which the former is enabled to receive nourishment and to get rid of effete matters, is termed the *Placenta*. Thus, in the process of embryonic development by a long and gradual series of changes the rudiment here depicted and described becomes a puppy, is born, and

then by steps even slower and less perceptible passes into the adult dog.

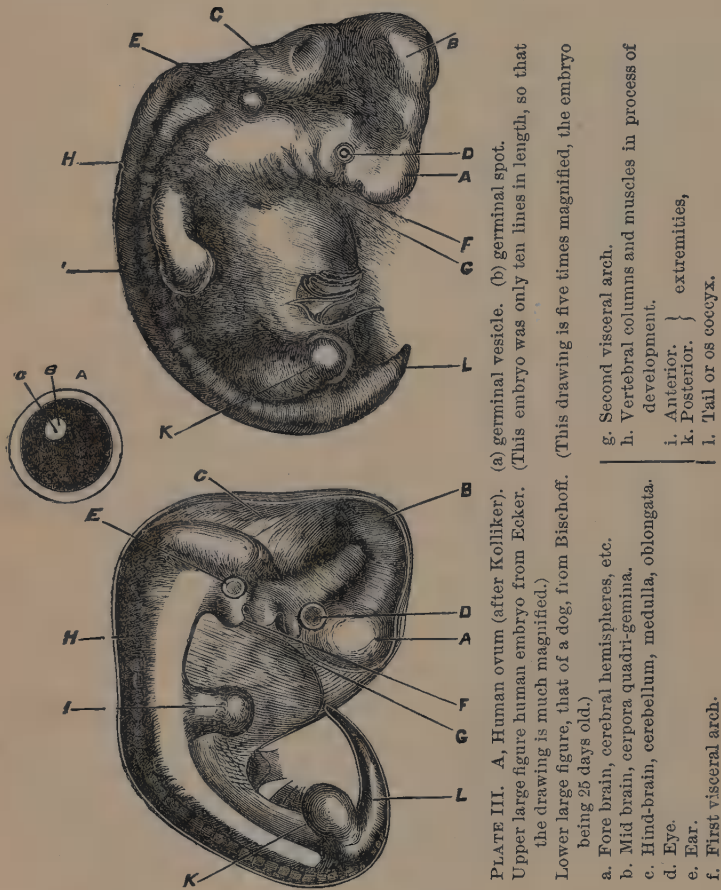
There is not much apparent resemblance between a fowl and a dog; yet the embryologist discovers that the young bird commences its existence as an egg in all essential respects primarily the same with that of a dog; but that the yelk of this egg undergoes division, that the primitive groove arises and that the contiguous parts of the germ are fashioned by precisely similar methods into a young bird which at one stage of its existence is so like the nascent dog that ordinary inspection would hardly distinguish between them.

The manner of the development of any other vertebrate animal is much after the same fashion. There is always to begin with an egg having the same essential structure with that of the dog; the yelk of that egg always undergoes division or as it is called segmentation, the ultimate results of that segmentation constitute the structural materials of the body of the young animal; and this is built up round a primitive groove in the floor of which a notochord is developed. There is, moreover, a period in which the young of all vertebrate animals resemble one another not merely in outward form but in all essential of structure so closely that the differences between them are inconsiderable while in their subsequent course they diverge more and more widely from one another. And it is a general law that the more closely any animals resemble one another in adult structure the longer and more closely do their embryos resemble one another; so that, for example, the embryos of a snake and a lizard resemble one another longer than do those of a snake and a bird; and the embryo of a dog and a cat resemble one another for a far longer period than do those of a dog and a bird, or of a dog and an opossum, or even than those of a dog and a monkey.

The mode of origin and the early stages of the development of man are primarily the same with those of the animals immediately below him in the scale, and it is determined beyond doubt that in those respects he is much nearer to the apes than the apes are to the dog. He originates in a similar germ, passes through the same slow and gradually progressive modifications; depends on the same contrivances for protection and nutrition, and finally enters the world by the help of the same mechanism.

The human ovule is about the 125th of an inch in diameter and might be described in the same terms as that of the dog so that we need only refer to the figure illustrative of its structure. It leaves the organ in which it is formed and enters the organic chamber prepared for its reception in the same way, the conditions of its development being in all respects the same. It has not yet been

possible and only by some rare chance can it ever be possible to study the human ovum in so early a stage of development as that of yelk-division, but there is every reason to conclude that the changes it undergoes are identical with those exhibited by the ova of other vertebrate animals. The remarkable correspondence between the early stages of the canine and human embryos becomes, from what we have seen. more apparent as the development advances.



At a tolerably early period the body of the young human being becomes distinguishable from that of the young dog by the different form of their adjuncts the yelk-sack and the allantois. The former in the dog becomes long and spindle shaped while in man it remains spherical; the latter in the dog attains an extremely large size and the vascular processes which are developed from it and eventually give rise to the formation of the Placenta (taking root as it were in

the parental organism so as to draw nourishment therefrom as the root of a tree extracts it from the soil), are arranged in an encircling zone while in man the allantois remains comparatively small and its vascular rootlets are eventually restricted to one disc-like spot. Hence while the placenta of the dog is like a girdle that of man has the cake-like form indicted by the name of the organ. But precisely in those respects in which the developing man differs from the dog he resembles the ape which like man has a spheroidal yolk-sac, and a discoidal, sometimes partially lobed, placenta. So that it is only in quite the latter stages of development that the young human being presents marked differences from the young ape while the latter departs in its development as much from the dog as the man does. This it is seen appears to show the structural unity of man with the rest of the animal world and more closely with the apes.

In all living beings there are several distinct parts set apart to perform particular functions, to operate in particular ways. These are termed "organs" and the living being is termed "organic." And as it is universally characteristic of living beings this term "organic" has been conveniently employed to denote the whole of living nature, the whole of the vegetable and animal world and therefore in the common acceptance of the term "organic nature" is synonymous with living nature.

The matter constituting the living world is identical with that which forms the inorganic world, and the powers or forces which are exerted by living beings are either identical with those which exist in the inorganic world or they are convertible into them; just in the same sense as the research of physical philosophy has shown that heat is convertible into electricity, electricity into magnetism, magnetism into chemical or mechanical force, and any one of those with the other, each being measurable in terms of the other, even so that great law is applicable to the living world. The difference therefore between the forces of the organic and inorganic world arises from the diverse combination and disposition of identical forces, and not from any primary difference.

The animal kingdom consists of seven primary divisions or sub-kingdoms (not including the microscopic animals); as the Vertebrata, or those distinguished by an internal bony skeleton; the Articulata, or those distinguished by an external bony skeleton composed of joints, as the lobster, centipede, &c., the Annulosa, or the worm tribes; the Insecta, insects; the Mollusca, or soft bodied animals, as shell-fish; the Calenterata or polyps, and the Radiata, including the sexless protozoa, and infusoria and sponges, the lowest forms of animal life. There is a certain unity of structural plan peculiar to

each of these sub-kingdoms which distinguishes and characterizes all its tribes, and by which it differs from all the other sub-kingdoms and their tribes.

Now it is found that distinct as these plans of structure are, every animal begins its existence with one and the same primitive form, namely, that of the egg, consisting, as we have seen, of an introgenous substance having a small particle or nucleus in its centre. Furthermore, the early changes of each are substantially the same, and it is in this consists the true unity of organization of the whole animal kingdom which has been imagined for centuries, but has been left to the present time to be demonstrated by the careful study of development. Moreover, it is now proved that the whole of the organic world is reducible to one primitive condition of form; that every plant begins its existence under the same form, that is to say, in that of a cell, the particle of introgenous matter having substantially the same conditions as the animal ovule. So that if you trace back to its germ any plant or animal you choose to name you shall find each and all of them to commence their existence in forms essentially similar to each other, and further, that the first processes of growth and many of the subsequent modifications are essentially the same in principle in almost all.

Finally, we may say that there is nothing yet known either historically or experimentally concerning the origin of living beings, or, in other words, concerning an origin of organic nature or organic life other than as we see now and which has been in these pages to some extent depicted and described.

The mode of perpetuation and modifications of form of living beings is therefore what engages the attention of naturalists and modern evolutionists rather than any question of origin. And we, for our part, while allowing that certain slight changes of form may have, in the course of time and from external conditions, taken place in species (for it may not appear improbable that some slight changes of form may take place in species, each returning after a cycle to its typical form again) yet we see no ground for justifying any theory which would derive all organic beings, animal and vegetable, from one primitive life-cell, or which would produce from species, entirely distinct species in any length of time.

Man stands at the head of the animal creation, and for all we know to the contrary, has ever occupied that place. He has ever in general propagated with his own species. This is illustrated by the fact that in all countries which have been discovered no order of animals exists as indicating a cross species between man and the lower orders of animals. The different species of apes, monkeys,

baboons etc., are distinct from man, and appear always to have been so. They differ from him not only in their appearance and habits, but in their bodily conformation also. Twenty-four alterations of structure, at least, would be required for the transmutation of one body of a gorilla into that of a man, all these in the physical organization alone. And the difference in the mental capacity is still greater; for while the average capacity of the Anglo-Saxon skull, which perhaps may be taken as nearly the average capacity of all human skulls, is 96 cubic inches; that of the gorilla is only $34\frac{1}{2}$; that of the Chimpanzee $27\frac{1}{2}$; and that of the Orang 26 cubic inches. These are the highest of the ape tribes; they come nearest to man in the scale of being; and yet, what a gulf separates those orders from mankind! But what eminently distinguishes man from all other orders of animals, is the capacity of mind which he possesses, the power of reasoning, which indeed gives rise to the power of speech; and without which speech, properly so called, could not exist. Some have ventured to enquire why the apes do not speak (for it may be remembered that no animal but man exercises the faculty of speech); as, say they, the organ of speech of the ape resembles that of man. Such enquirers do not consider that organs of speech must act according to the mind which employs them. Hence while man uses a glottis or vocal chords, which act in accordance with his reason, or logos, to form a language, the apes can employ but the same organs to produce a bark or a yell. Human beings in all parts of the world, however unenlightened they may be, know, as it were instinctively, the relation in which they stand to the lower orders of animals; and even in the regions of Africa, far away from the civilization and unacquainted with the ideas and habits of the white races, they preserve their place, and regard the apes with superstitious horror! Even in the earliest periods of our race of which geology thus far furnishes us any information we find its members displaying a certain ingenuity and tact in the making of tomahawks, arrows, etc., and for all we know to the contrary, they may have displayed great ingenuity in the construction of innumerable other things, every trace of which has ages since passed away. There was doubtless in all ages a difference of degree existing in respect to civilization, as there is now, among the different tribes of mankind. And even in the earlier geological times, we find them exercising the care of burying their dead or of burning them, which will, in the main, account for the fossil remains of man not being found strewed as broadcast as those of the lower land animals. Man has always exercised a care over the dead of his own species which none of the lower animals were capable of exercising. This of itself is enough to show that he

Cranial capacity, as referred to above, is not of itself a criterion as to superiority or inferiority within the human species. Out of 56 human skulls of ancient Peruvians (who were undoubtedly the most civilized of the ancient American races) measured by E. G. Squier, the average cranial capacity was only 75 cubic inches, which is much less

always possessed and exercised the power of reason and speech.* Would that he had always used this faculty aright! Well and happy would it thus have been for him! Even the *Quadrumana*, or ape-tribe, which come nearest to man in the scale of being, do not evince to us that they have any conception of care for their dead. All the care which they exhibit and which they have in common with all other animals, even the lowest, is for their young, and to supply their own physical wants. All the Indian tribes of North and South America, even in their most wild and savage state, have always, since the white men have become acquainted with them, given evidence of deep affection and care for their dead; and some of these tribes are accustomed to come periodically, bringing offerings and tears to their tombs! And every human being possessing the ordinary mental faculties of a human being, of whatever nation or language, you may meet with, will, if you find him in circumstances favorable for the intercommunication of ideas, give unmistakeable evidence of his possessing reason, and of his having some thoughts as to right and wrong much as you have yourself. How long ere human beings exercise such kindness towards each other as their kindred relation calls for? How long before all men will cultivate and exercise only the principle of benevolence, to be good and to do good? When that time has come, they will know what we say to be true, and each one will realize for one's self the application of the name which has long ago been given to the Eternal Father.

than that of the existing aborigines and about the same as that of the South Sea Islanders and Hottentots. Something, doubtless, may be judged from symmetry or disproportion of parts, but the whole human being made up of bodily and cranial parts is the unit of judgment. Heredity and education also may be taken into the account.

*The consideration of the great development of language among the civilized nations, ancient as well as modern, would go far to show man's true position in the scale of creation. This is especially so in the case of the Greek language, which is constructed with such mathematical precision, and which has been cultivated after that manner in such an early age. Also, in the Latin, which approaches the Greek in the beauty and the complexity of its construction, though not in the smoothness of its sound, man's mental superiority over the lower animals is no less apparent. Even in the construction of these two languages we see a very remarkable degree of skill displayed, and in their use during the historic ages, a wonderful development of reasoning power. But because the language of a nation does not display a great number of words, this is not a sufficient indication that it is not ingeniously constructed. Succinctness of expression gives power to language. The language of almost all the Indian tribes of America, South and North, including the Esquimaux, though differing much from each other as to root and sound, are all constructed upon the polysynthetic principle; that is, root is so added on to root, that quite a number of ideas may be expressed by one complex word. And these peoples do not give much attention to the niceties and the mathematical complexities of mood and tense, and case. For instance, one of the tribes, the Algonquins, are said by a missionary who has been amongst them, to have expressed the following number of ideas by one word, *nadholi-neen*: "Come and fetch us across the river in a canoe." But in some cases they express by very long words objects which in English are expressed by monosyllables. In the Pawnee language the word for day is *shakooeroeshai-ret*, and for devil it is *tsaheekshkakoorai-wah*. Their words, however, for these common objects may, for what we know, represent to their mind, complex ideas, i. e., may represent each a combination of many simple ideas. The Greek language, both as to its alphabet and construction, must have been in use in very early times. This is evident from the perfection it displayed, as compared with other ancient languages, even so early as the age of Homer, the 12th century B. C. It then had its several dialects of

LANGUAGE AS TO ITS ORIGIN AND DIVERSE NATURE AS INDICATIVE
OF THE ORIGIN OF MAN AND OF THE NATURE OF THE COSMICAL
PHENOMENA.

It is not only probable, but consistent with reason that language, that is, a capability of uttering certain sounds expressive of things and their inter-relations, was at the beginning bestowed on man, as a special endowment, by the same Almighty Being who imparted instinct to all the inferior animals, caused the ox to low, the horse to neigh, and gave to birds the ability to warble. In all ages and countries men have possessed the faculty of speech, which does not, in this connection, imply grammatical laws, that are themselves of human invention and of tardy growth, as I will illustrate more fully farther on; but the fact that tribes residing on islands far removed from the great centers of mankind, have never been found without language of some sort, shows that this capability is not the result of accident. There are said to be spoken on the earth about 900 languages; those, of course, including many dialects. Now, would not, say, 850 be as many as could have been expected to exist, if the origination of all or any of them had been dependent on accident? It would seem that in some instances other means would have been employed for the purpose of communicating thoughts.

If, as we know is the case, man is fitted for a high position in the present world, and, as is generally and reasonably believed, is ordained for a pre-eminent dignity in a future one, how can it rationally be concluded that he would have been introduced to the world by his Creator in a condition most degraded, and for, no one knows, how long, perfectly mute, excepting the capability of uttering a scream or a grunt? The answer to the question, why are things as they are, in regard to the general cosmical phenomena, is

the Doric, Ionic, Æolic, and Attic, which all after yielded in perfection to the perfected Attic. The Latin also, which, as the Attic, was the perfected product of many Italian dialects, must have had a very early origin as to its characters and construction since that we meet with the construction of mood, and tense, and case, even in the earliest authors of this language, as in the Greek. The characters and constructions of these two languages are old, and the thought of their authors is old, and indicative of true human feeling. The thoughts on language expressed in this foot-note introduces us to the very interesting chapter which follows.

that the Creator is omniscient and omnipotent; but even if the Creator were not allwise and omnipotent, there is no reason present to our mind why a low condition should precede a higher one for our species, as the protoplasmic and gradual development theory implies; for there is as much skill required in the formation of an animal that can not speak as in the case of one that can, as one will conclude who takes into consideration the diversity of compensatory instincts among the various species of animals, and for the origination of something whence all would naturally spring, as for the production, at will, of all and each in a comparatively perfect state, that is, when we take into consideration the origination of something out of nothing. It is, for example, unreasonable to suppose that the Creator would have commenced His work of constructing man by the creation of a protoplasm, monad, or whatever else the something may be termed. It is still more so to imagine that the protoplasmic something was produced out of nothing by an agent which had not begun to exist. But if it be admitted that the universe was the production of the Supreme Being, why should it be imagined that He could not, at the first, have created a man as easily as a monad? No conceivable arrangement or form of mere material particles can be conceived apart from inertness. What, then, do we suppose, occasions intelligence? If a rock, a vegetable, a brute animal and a man are intrinsically dissimilar, what can we conceive, except the will of the Creator, should have produced the difference? Although the visible form of the whole is material, yet the first is without organic life; the second is destitute of sense and consciousness; the third is deficient of speech; while the fourth is endowed with reason and speech, and an intellect whose capabilities are apparently limitless, having bodily organs, too, adapted to these high faculties. If these are to be considered, as designed by the Creator to have been and to be, as they are, distinct, insuperable difficulties are avoided.

The question may fairly be asked: If the immediate progenitors of men were apes, which rose above their condition without any apparent cause, how is it that other animals as well as our Simian ancestors did not analogously rise? . If the bird, the bee, or the dog is now as it ever has been, why should man, unless formed on a different principle, have been continually rising or sinking correspondingly with the advantages or disadvantages of circumstances and conditions for changing or improving his natural faculties? If the most intelligent man or the most beautiful woman has descended from a gorilla, how is it that Simian tribes in a transition state have

not been found to become in any perceptible way orators, painters, sculptors, musicians, politicians, theologians, blacksmiths, editors, inventors, authors? What an unprecedented attraction, what an enriching speculation for a showman it would be to open an exhibition of works of art, the products of the twenty-fingered apes of some newly-discovered region! If, however, these creatures have the root of humanity in them they surely can be cultured. Hence, in the first place, they must be shaped into the human form; their arms, etc., must be considerably altered. They must be taught to read and write; ciphering, geography and the use of the globes must be included in their curriculum. How about speech? Gymnastics, they have enough of that, but they must be made graceful and genteel. There will, of course, be a distinction in the education of the ladies and gentlemen. The male and the fair sex must have injected into them, by all means, moral principles, of religion and science, of social and political economy, with, of course, a long category of other important items, and the motto of the teachers must be to the end — *in seculis seculorum nihil desperandum*. Now, as to the question of the antiquity of man, it is well known that nothing more positive can be said than that it is certainly greater than was formerly supposed. But, as to the question of origin, whether men arose gradually from some inferior species, and this from something lower, while the original was dependent on spontaneous generation; that, indeed, all animals and plants worked their way up to comparative perfection by a kind of blind inclination; that the first germ of existence sprang out of nothing, which is as reasonable to be said as that it sprung from a monad; and that all subsequent varieties arose from nothing or from accidental causes, is not to be compared on the ground merely of rationality, with the belief that all things were produced by and are dependent upon the will and wisdom of an omnipotent, omniscient and omnipresent Creator. Indeed, the omnipresence of the Creator being once admitted, all that is attributed to Him is easily and reasonably admitted, for all His other attributes are necessarily adjuncts to His omnipresence.

There is among men a universal disposition to cherish a certain kind of pride in the high character and noble deeds of their ancestors. A hero, it is true, may be such in the sense of being a champion for the cause of truth and righteousness, although this is not the usual sense had of the designation of a hero, but there is no man who would not feel more gratified in being able to point back to a hero of some sort in his family lineage than to one who

had disgraced the name, and this characteristic of individuals is seen on a large scale in nations. The most celebrated historic nations have traced their origin to heroes or demi-gods, while the great human family has been attributed directly or indirectly to the immortal gods, and by the more intelligent to the Lord Almighty, who, it is said in Holy Writ, created man in His own image. But what is the origin to which some modern theorists have attributed the human race? To what image? Why, to that of a baboon or gorilla! If, then, apes were the progenitors of men, how is it that they are now contemporaneous? What occasioned some to be developed into human beings, and others during thousands of years to be debarred this privilege? The Simian and the human tribe appear to have been in all parts of the world distinctly separate. Among a countless number of species there will, of course, be some kind of resemblance of the one to the other without any connection as to parentage; otherwise we might go from those possessing greater to those possessing less similarity and derive all, the whale and the butterfly, for instance, with Plato, Shakespeare, Laplace and Newton from one stock. There is no doubt that human beings have existed in a very degraded condition, even in the historical ages. By isolation, etc., similar effects may be produced in a few generations; but this does not pertain to the question of origin. Man may be traced from the lowest condition of savagism to the highest state of civilization; but where is there any evidence of transition from apes to men, or of gradual improvement in the former, when, if at all, they must be ripening for manhood? No one has ever heard of a colony of advanced apes which walked and ran erect, nor of a tribe of human beings who proceeded on all fours. And is it not strange that, if the two classes stood in the relationship of fathers and sons, they have never been found associated together? The former, in every instance, have not only been destitute of the power of speech, and therefore incapable of improvement, but they have been also ignorant of the use of fire, the processes of cooking, and of every domestic and mechanical art. We may go not only to the intellectual and refined among human beings to receive a scornful negative as to their parentage in the Simian tribes, but even the most barbarous nations in existence would deny the imputation of their descent from such progenitors.

It seems, according to the theory of some writers, that the Almighty created nothing, or allowed nothing to be generated, except by an indirect and tedious process. Thus, in regard to human beings, some principle of life was produced, and then some-

thing a little higher, until, after a vast period, monkey tribes appeared on the earth; and, subsequently to no one can tell how many ages, after innumerable modifications, the crowning work was accomplished—the creation or manifestation of man. Also, in regard to religion, that a certain system was introduced by the Supreme Being, the worship, for instance, of the sun, moon, and stars; then the adoration of fictitious gods; then of animals, plants or graven images, as representations of feigned divinities! According to this theory, the God of truth would not manifest himself except by false indications! He taught the human race to believe in divine personages which had no existence, to embrace error as a preparative for truth, to practice absurd, cruel, and repulsive rites as a training for pure and exalted worship! And that by such modes the way was made clear for the introduction of the dispensations of Moses and of Christ.

But the better and more correct parallel would be, not that inferior animals were divinely necessitated to be the progenitors of man, nor idolatry ordained to be the stepping stone to true religion; but that, whether one kind preceded the other in time, or, in some ages, both were contemporaneous, man was a distinct creation as such; and that originally created high, the true religion was established in him, by which he needed not any institution of the worship of false gods, to lead him to an apprehension of the True One. Further, man having been endowed with the faculty of reason, was capable of judging as to probabilities; hence he would infer that what existed around him was produced by a Being of great power and wisdom, and that a feeling of dependence upon Him for life and breath and all things was perfectly just. The results arising from this conclusion would be modified by such a variety of influences as we find to operate in the world around us. The teachings of the wise would be corrupted by the superstitious; self-interest, being put into the balance, would outweigh humility, the parent of godliness; and, as we find in history happened, the light of reason and humanity would become shrouded in clouds and darkness. Nations, in respect to morals, civilization, and intelligence, have been continually rising and sinking. If we look at Egypt, Abyssinia, Ethiopia, and other parts of Africa and Asia, we shall see illustrations of this fact. Even Jews and Christians have been reduced to a barbaric state. A flourishing city may be ruined by war, the inhabitants dispersed in greater or smaller numbers, and gradually lowered to semi-savageism. Something of this kind may happen with an individual, and so with a people. A youth

may be highly cultivated, but circumstances compel him to make his settlement amongst an uneducated and uncultivated class of people, apart from refined society. By degrees he loses his learning, his refinement is succeeded by comparative coarseness, his religious principles by indifference or superstition. His children may grow up as a lower type, and theirs still lower in the scale of humanity. Thus, human beings, cut off from intercourse with the civilized, deprived of books and all arts of refinement, would most certainly sink into barbarism. Besides, when tribe is set against tribe, revenge and personal safety are the leading motives of action: hence war and savagery are the natural result. Ten generations would thus reduce a people to a very low moral and intellectual condition, while thirty or forty might exhibit them without mechanical or domestic arts, living in dens and caves. They might, indeed, even become cannibals! When, as in ancient times, the inhabitants of a district were dependent on the chase, and beasts and birds were nearly exterminated or not to be found—as with the New Zealanders—they must either starve or turn on their fellow human beings and make prey of them. We can easily imagine how a life of this kind must transform human beings to savages. And, yet, in their lowest condition, there is no evidence but that men were as perfectly distinct from monkey tribes as human beings are in the present day.

Many persons are apt to imagine that, as the inhabitants of the earth are now generally fraternizing and assisting each other to emerge from barbarism, consequent upon the spirit and spread of Christianity, it was much the same always; but in the early ages the influence was in the contrary direction. Peoples were separated by almost impassable tracts of country, by mountains, by unnavigated oceans, and by a total ignorance of any language but their own. Hence, it is not surprising that they were all immersed in barbarism. When, however, facilities offered, the intellect was roused from its dormant state and mighty empires were established, to be, after a few centuries, in their turn, broken up and succeeded by savageism. Relics of civilization, embracing marvelous productions of art, are still found in the midst of deserts, visited by wandering tribes, the descendants, perhaps, of architects and legislators, rare sculptors and painters, moralists and poets, the traditions of whose mighty works have been faintly echoed from age to age.

It would be a glorious event, if at any time all the nations and tribes of this globe were brought into a state of universal inter-

course by means of a single language, the four thousand dialects having been reduced to one! The telegraph wires and postal routes all over the world would then communicate only what could be known and read by all men! What a powerful agent of civilization we might conceive this to be for abolishing eccentricities, for rooting out barbarism, and for bringing the manners and customs of mankind to one universal standard. Five or six and twenty letters would then rule the world! To this result some philosophers think there is a gradual tendency. There is a gradual absorption of countries by powerful states, and consequently a gradual extinction of diversities of speech; also a voluntary tendency to form confederations. In all the departments of human life there is a tendency to act on the principle that "in union is strength." Thus individuals form themselves into corporations and endeavor to enlarge their power while they benefit others. Instead of small independencies with a certain amount of isolation, there come to be thus large systems with a small portion of individual freedom. This is, doubtless, in a great measure, occasioned by increased intercourse; and whether it be a union of several individuals into one corporation, or of many states into one vast republic, the effect is somewhat similar, a more complete intercourse occasions agreement in the style of language.

But the bringing of all the people of the earth to the use of one language is a result which probably can never be realized. Let the facilities of inter-communication be as great as the most sanguine can imagine, yet there will always be, as to time and space, vast barriers between some tribes and others. The great mass of the people of the world — the settled population — are not, except in a limited sense, migratory. Besides, the dwellers in the regions of the tropics and of the poles are not likely to change places in large numbers, — if so, they would be likely to soon change their languages respectively to suit their surroundings. The languages of the tropics, for example, adapted to all that is brilliant and gorgeous in nature, must be widely different from those used in the barren, chilly, snow-covered regions of the poles. Circumstances, to a large extent, make language what it is, that is, it is drawn from and adapted to the objects we have around us. Among the vast number of nations there is an endless variety of natural products, manufactures, religion, customs, etc., all of which must have their verbal exponents; consequently one language for the whole, even if it could be established, would be so enormously copious, that it would require more than human memory to retain it; and

the result would be likely to be that every people would go back to the verbal system adapted to its own necessities. The means of subsistence will also keep the masses of the fourteen hundred millions of the peoples of the earth from ever mingling with each other. And even if intercourse were greatly increased, it hardly might be expected that differences in religious opinion would cease to exist. Even in the same country certain religions hold by and maintain as sacred particular languages, the Jews, Hebrew; the Mahometans, Arabic; the Hindoos, Sanscrit; the Roman Catholics, Latin, etc.; important influences these for preventing uniformity of language. As I have said before, only very small portions of the peoples of the earth ever have or ever can have occasion to mingle with each other; the great bodies of the peoples are settled down, and know nothing, comparatively speaking, about nations foreign to their own; the very few have occasion to migrate or travel.

Verbal inter-communication between different peoples is carried on not by sinking some words and adopting others in common, — by giving and taking, as it were, — but by learning the constituent parts of each others language and preserving the differences. As the language of a country becomes perfected, it is, in its grammatical structure, more completely distinguished from that of others. Human speech partakes of the mutability connected with earthly things. According to the opinion of some linguists, all the languages of the world were derived from one source, and being established in different localities, have exhibited, with the fluctuations, employments, customs, opinions, etc., of peoples, a ceaseless disposition to change. Since the globularity of the earth has become in the mind a matter of fact, proved to demonstration by experiment and observation, and intercourse has been established with so many nations before unknown, so many items have been added to the stock of knowledge concerning language and its origin that others have seen fit to condemn this opinion as erroneous.

But, with respect to the changes which languages undergo, we find, for example, the early dialects of the Greek to have become refined into the Attic; the latter degraded to the Hellenistic, and this again improved to the Romaic. Latin, itself the perfected product of the Italian dialects, became the foundation, not only of the modern Italian, but in a less degree of French, Spanish, and some other southern European tongues. In regard to English, it may be observed that the language of the Heptarchy differs as much from that of the nineteenth century as the Latin differs from the present Italian. There have, in reality, several tongues succeeded each

other in Great Britain, as far back as history takes us: First, the Celtic, of the ancient Brittons (of which we may suppose the Welsh and the Gaelic to be the living representatives); then a mixture of this with that of the Roman conquerors; then, what has been termed the British Saxon; next, the Danish Saxon; then, the Norman Saxon. After this period a still greater admixture of French was adopted, it being usual to send youths to France to be educated, while the records of the kingdom were kept in that language. Latin, also, was a part of the ordinary education, so that Saxon became well nigh obsolete. In a few of the monasteries it fortunately happened that provision was made by the appointment of professors for the preservation of Saxon literature, and by this means, principally the language was preserved. But for this, instead of being trained in the English tongue, we might now be taught to clothe our ideas in language somewhat like the French. At the time to which I refer, the Saxon was deemed low and discreditable, fit only for the vulgar; on the contrary, French was deemed genteel! By degrees the former language gained the ascendancy, and was used as the medium, not only of colloquial intercourse, but of history, poetry, and composition in general. In later ages the English tongue has been subject to considerable changes. The writings of Wycliff, Chaucer, Gower, etc., can scarcely be read without glosses, and, sooner or later, this course will have to be followed with Shakespeare and Spenser; but as we come onward the difficulty gradually diminishes.

As languages have a tendency to change, there is no good reason why we may expect them to be cured of this disposition. If anything could tend to the stability of orthographic forms, it would be the effects of the art of printing; for among the scribes, too frequently, every one did what was right in his own eyes, and hence it was not unusual for words in the same composition to be spelled differently; whereas, when books are rapidly produced, and one copy is necessarily correspondent with another, while there are such orthographical standards as Webster, Worcester, Richardson, and others, changes are not so likely to occur; and yet, within three centuries, the changes have been so surprisingly great that there appears to be no possibility of preventing a greater or less gradual change of the meaning and the adoption of words.

It is with some a conjecture (whether or not there may be any ground for it), that there are more or less differences in the structure of the vocal organs among various peoples, as well as different characteristics in the form of the cranium. That these dissimilari-

ties, which may arise from climate, food, etc., are perpetuated by inter-marriage, and tend to produce a diversity of sound, orthography and, consequently, of language. The recent study of philology, in its world-wide relation, has opened up an extensive field for investigation and speculation — the American languages, as well as those of northern Asia and Africa, coming strongly under consideration — and enough appears to be known for any reasonable man who has turned his attention fully to the subject to decide for himself the question of the origin of language. In the progress of this philological research, much has been discovered from the relics of past ages, preserved in inscriptions on stone, amid the ruins of ancient temples and buildings, long buried in the earth, giving us information on subjects, concerning which the world had been unenlightened, scattering to the winds theories sometimes held concerning the origin of nations and languages, and showing it to be more probable that man, originally high, sank himself into barbarism, than that, originally low, he ascended to a high condition of civilization and refinement. Both hemispheres have each largely contributed to those antiquarian discoveries.

It is utterly astonishing what a variety of words can be produced from one alphabet. Max Muller, following Leibnitz, informs us that by putting together the 23 or 24 letters in every possible way we might form every word which has ever been or ever will be used. The result of 20 letters as a basis amounts to the amazing number of nearly 26 sextillions, and of 24 letters to nearly $620\frac{1}{2}$ sextillions of words. The most comprehensive English dictionary as yet compiled contains only about 100,000 words, one-third of which have been added since Dr. Johnson compiled his. This, however, forms a very copious language, and indicates the immense extent of the employments, inventions, and informations of the people. These words are derived from many sources, as for example, the different branches of the Celtic, Gothic, Latinic, Greek, Hebrew, Arabic, etc., and many of them are derived from the names designating new inventions and their relations. This being the case we may in general easily trace the pedigree of words in our language to their sources, and it is owing to the junction of so many streamlets that the English language is so copious. If a writer in our language is sometimes hard up for an appropriate word, the fault is likely to be in himself. I remember having read the complaint of a poet, who claimed he could find nothing suitable to rhyme with a word he had used and therefore he left a blank, on which, some one possessing a better stored mind, or perhaps a finer ear, supplied thirty vocables,

either one of which would rhyme with the one he had consigned to "single blessedness." As another illustration of the copiousness of our language, and of the abundant capability of supply in the mind of some poets, it may be mentioned that Southey, in his poem on the "Cataract of Lodore," has used about 150 adjectives as applicable to running water. A true and full poet, if any one, must, I should judge, be worthy the appellation of "a walking dictionary."

But, notwithstanding the use which has been made of letters in forming vocables for our convenience, what an insignificant item is 100,000 words as compared with 620 sextillions! We can consider for a moment what a sextillion is, and then calculate how many lifetimes would be required to utter that number of words at the rate of 100 in a minute and 10 hours in a day. This, reckoning the year at 365 days, we find to amount to, in years, 45 trillions, 662 billions, 100 millions, 456 thousands and 621. And this vast number we can multiply by nearly $620\frac{1}{2}$ to express the multiplicity of vocables, or the result of the permutations and combinations of 24 letters of the alphabet.

To the question, Why it is that only human beings speak, and not also the other races of animals, some of which are endowed with faculties in many respects so like those of human beings? it is fairly answered that, although many species of the lower animals are not utterly destitute of the power of communicating together, yet their means and manner of communication are entirely different from what we call language. The principle characteristic of human speech is that it is arbitrary and conventional; of that of the lower animals, on the other hand, is that it is natural and instinctive. The former is capable of indefinite change, growth, and developement; the latter is unvarying, and does not, so far as we see, transcend its original narrow limits. The one is acquired by instruction as well as naturally, and handed down by tradition and history; the other, to our observation, at least, appears in its integrity in every individual of the race. But, for the superiority of man is this particular, the reason that his endowments are vastly higher than those of the inferior races, is generally regarded as the most satisfactory that can be given; the fundamental reason is that it is the will of the Creator that this should so be. We are accustomed to agree that man is distinguished from the lower animals by the possession of reason, but then we can only define reason as that by which man is distinguished from the lower animals: for as to what reason is, how far it is a difference of kind and how

far one of degree only, men hitherto have been quite at a loss to tell. When philosophers shall have determined wherein lies the superiority of man's mind, they will have gone far towards explaining in detail his exclusive possession of what is properly called language. To say that the brute is governed by instinct instead of reason, does not, by any means, solve the problem, it is but giving a name to a distinction whose nature we do not comprehend. Wherever the line can be drawn between the so-called "blind instinct" of the ant and the bee and the "free intelligence," as we are accustomed to term it, of man, that line, we all agree, is long passed when we come to some of the higher animals, as, for example, the dog. All agree in attributing to this animal the possession of an intelligence which is real, even though bounded by narrower limits than those which circumscribe our own. Anything in the animal shape wearing the semblance of intelligence necessarily implies in itself the power of forming general ideas. If the crow did not recognize what a man is, why should it fear a scarecrow? If Ulysses' dog did not possess the faculty of memory, how was it that he recognized his master after an absence of twenty years? And is it not the height of absurdity to maintain, for instance, that the dog and many another animal does not apprehend the idea of a human being, does not remember one it has long experienced kindness from, and does not, whenever it sees a new individual of the class, recognize it as such, as having like qualities and likely to do such things as other individuals of the class have done before under its observation? Moreover, how is any application of the results of past experience to the direction and government of present action — such as the lower animals are capable of — possible without the aid of general conceptions? That many animals come so near to a capacity for language as to be able to understand it when addressed to them by man, is well known, and their condition is considered analogous to that of very young children, whose power of understanding language is developed sooner and more rapidly than their power of using it, who come to apprehend a great many things before they begin to express them. To identify reason, then, with the single mental capacity of forming general conceptions, and to trace the possession of speech directly to this capacity must necessarily be erroneous. It is part of that superficial and unsound philosophy which confounds and identifies, speech, reason, and thought. While speech is one of the most remarkable and valuable of the manifestations of reason, yet, even without speech, reason would be reason, and man would be man, though far below

what he was meant to become, and is capable of becoming through the developing and improving power of speech ; for there are many other things besides talking which man can do by virtue of his reason, and which surpass the ability of any other animal. Yet, in respect of capacity, it is very evident that the distance which separates the oyster, which is totally incapable of being trained to know anything, from one of the higher varieties of the dog, is vastly greater than that which separates the dog from the uneducated man, or a man of one of the lowest races. There is scarcely to be found in the whole animal creation any being more ignoble and horrifying than are those specimens of savage and ferocious men which history and travel occasionally present to our contemplation. But what we have above them has been gained mainly through the instrumentality of language, and is the product of a progressive accumulation and transmission of human experience. Language is that which enables men to be, as they are intended to be, social and not merely gregarious beings ; as it is the result so is it also the means and instrument of community. It converts the human race from a bare aggregate of individuals into community, having a joint life, a common education, to which each individual contributes his portion, receiving for himself, in return, an inestimable treasure. It alone makes history possible. Our endowments, so much higher than those of the brutes, need also, as being so much freer and less instinctive, to be drawn out and developed. The speechless man is a being of undeveloped powers, having within him the seeds of all that is great and good, but seeds which absolutely require language to fertilize and bring to fruit. Language enables each generation to store up and hand down to its successors its own collected wisdom, its treasures of experience, observation, deduction, and invention, so that each individual may start from the point whereat his predecessor left off, and all commence their life's career heir to the gathered wealth of the past. If each human being had to begin for himself, the course of education and improvement, all the energies of the race, must necessarily be absorbed in taking over and over again the elementary steps. Men do not realize how much of the observation, invention, and study of the men of past ages is stored up in the mere words which they use so lightly, and what degree of culture their minds receive, almost without perceiving it, by entering in this way into the fruits of their labors. A solitary man would never frame a language. Let a child grow up in utter seclusion, and however suggestive might be the nature around him, however keen and appreciative his

sense of that which lay without and his consciousness of that which went on within him, he would all his life be destitute of language. On the other hand, let two children grow up together, wholly untaught to speak, and they would devise gradually some means of communicating together, how rudimentary and of how slow growth we can not tell. We may reasonably suppose the character of the speech produced would vary with difference of capacity, with natural or accidental differences of circumstances and the like; but it is quite certain that human beings of such kind, and placed in such circumstances as we have supposed, would not remain long in each other's society without successful efforts at intelligent interchange of thought. Again, it is found that if one who had grown up even to manhood in free intercourse and communication with his fellow-men, became separated from them and forced to live long in solitude, he would, by disuse, gradually unlearn his native language, and be found, at last, unable to converse otherwise than very imperfectly, until he should have recovered, by practice, his former facility of expression.

There have been those in times now past who have strongly insisted upon what they termed "the divine origin of language," who have pretended it to be in some way derogatory to the honor of the Creator to deny that He devised the roots and words, and by some extraordinary and exceptional agency put them, ready-made, into the mouths of the first human beings. Of such it would have been fair to ask whether the hand of the Creator is any the less clearly to be recognized, and need be any the less piously acknowledged in its production, if we regard man himself as having been created with the necessary capacities, powers, and impulses for forming language, and then as having come into the possession of it through their natural and conscious operations. Articulate speech pertains characteristically, universally, and exclusively to man. There is no tribe of human beings, however low, ignorant and brutish, which fails to speak; there is no race of the lower animals, however high in the scale towards man, which are enabled to do so. It plainly, therefore, was as much a part of the Creator's design that men should talk as that they should walk, eat and drink, and that they should be themselves the originators of their systematically or grammatically constructed language rather than receive such as a primal gift. Nineteen-twentieths of the words we use are our own work, why should the remaining twentieth be thought otherwise? The actual germs of language, as is well known to the philologist, were a scanty list of meager roots, representing a few

of the most obvious, sensible acts and phenomena, appearing in ourselves, our fellow-creatures, and in nature around us, and all the abundance of language which we now possess has grown by long accumulation out of such a primeval poverty. That philosophy is rather childish than puerile which can perceive no other way to make out a divine agency in human language than by regarding that agency as specially and miraculously efficient in its first origin. It is of a piece with the suggestion which was generally thrown out and listened to when the facts of geology were first beginning to be revealed, namely, that fossils and stratifications and such like facts proved nothing, since God, when He created the rocks, could just as well have created them in this form and with these contents in as otherwise. With men who can seriously argue on such assumptions it is the height of folly to undertake to discuss a historical question. All the influences of historical and of prehistorical science is thrown away upon them. They are capable of believing that a tree which they have not themselves seen spring up from the seed was created whole in the state in which they find it without gradual growth, if not that a steamboat, a watch, or a house were produced just as they are by the immediate action of divine power. But, in the case of language, the power which originates is not to be separated from that which sustains and developes; they are one both in their nature and mode of action, though this be mysterious and not understood by men, for, if the limited powers and dullness of perception, characteristic of men in general, seem to have prevented them or caused them in all, or almost all, cases hitherto to hesitate from dispensing with the idea of secondary causes in the production of any thing or event, why should this agitate any Christian teacher as it doth not effect any change in his position theologically. In fact, his position as a doctor or teacher supposes such ignorance or dullness of perception in men as I have adverted to, otherwise what would be the use of such teachers, I mean, if the pupils had by some means become as wise as their teachers. The question may in general be safely asked, can any one say that secondary causes do not exist? for in the state of the general mind in the present age a positive answer to this question would be properly considered presumptuous and ridiculous. But there do seem to exist in the minds of men two apparently opposite conclusions concerning the cosmical phenomena and their substratum; according to the one side, all is natural and no supernatural; and, according to the other side, all is supernatural and no natural. Or, according to the one side, all is miraculou~~s~~e and no natural; according to the other side,

all is natural and no miracle. The qualifications and limitations, however, which almost invariably will be found tagged on to each of these positions respectively, if fully reasoned out, will be likely to bring the two professed understandings to a common, middle ground, reduce the extremes to a mean, and show them to be identical. Now, since this is really the case, what is the use or reason of the professors of those seemingly opposite beliefs being so severe on each other as they occasionally are found to be on the rostrum, in their writings, and in their hearts, as we know must be the case when one party threatens to have the other arrested by the civil authorities on account of some profession of his concerning religion which the former chooses to call by some hard name and categorizes under some old barbarous, criminal caption. This is simply persecution, similar to that of the Inquisition and arising from the same spirit, a wicked, dark, and brutal disposition. These remarks are not drawn from any experience I have had myself personally, but from my observation of how some others in this latter part of the nineteenth century are disposed to act toward their neighbors. When the party evincing such a disposition is titled or only clothed under the name of a Christian profession it is particularly scandalous, for it arises from the source whence we should naturally and reasonably look for more intelligence than such a barbarous course would imply or justify. The principal planks in the Christian platform are self-denial and active godliness, and while the former implies an absence from persecuting others, on account of their religious belief, by the Christian; active godliness implies that the benefit of all, even of those who might, through ignorance, oppose the Christian name, should be sought, and that their good, not their detriment, should be kept in view.

To reconcile differences on cosmetheologic subjects, such as those referred to, even though they be rather apparent than real, not only the display of a gentle and charitable disposition, but a knowledge of language in all its varieties, such as allegoric, parabolic, etc., as well as literal, is necessary and helpful. As implied in what has been said before in this chapter, language is not thought, it is the symbol of thought, the representative of ideas, or their relations to each other. The correspondence of words with ideas, of language with science, enables us to see the prevailing employments of people by looking at their *copia verborum*. Thus, Latin is copiously supplied with words relating to war and agriculture; Greek with those relating to the fine arts, moral philosophy, etc. Arabic is furnished with

more words than are to be found in any other contemporary language pertaining to alchemy and chemistry. Hence, a country bordering on the ocean, an inland country, an arid desert, or a district abounding in rivers and lakes, a region clothed with countless varieties of vegetation or stretched out in barren steppes and prairies; fragrant with the spices of Arabia, or blasted with the malaria of Sierra Leone or Gambia; scorched by a tropical sun or congealed amid solar darkness, will express in its language the character of the country, with the employments, habits, etc., of the peoples. Thus, according to Liebig, the chronology of the Rhinelander is calculated not on calendar, but on wine years, and their speech is varied with original expressions, having reference to the culture of the vine and the produce therefrom. These, he adds, are sufficiently numerous to form a lexicon. Thus, also, the seaman, the soldier, the sportsman, the mechanic, etc., model their language agreeably to the things with which they are familiar.

As words are symbols of ideas the former will be copious in proportion to the latter. An educated person will probably use for colloquial purposes about 4,000 words; and it seldom happens that eminent writers or orators go beyond 10,000. Shakespeare, who is remarkable for the variety of his language, employs as many as 15,000. On account of the great variety of pursuits, and the great number of modern inventions of the peoples who speak it, the English language is very full and expressive. It is not, of course, perfect; but, being composed of several languages, it embraces many of the excellencies and avoids many of the defects of other tongues. It, in fact, combines, in an eminent degree, strength with harmony in the language of philosophy and poetry, of political and moral science. I think it was by Sheridan it was observed that, like the Apollo of Belvidere, it unites the three qualities of strength, beauty, and grace.

Words, in general, are so variable in their signification that they may be used to express or conceal our thoughts. We may employ them figuratively or literally. We may make them the agents of expressing startling paradoxes, or flat contradictions. We may employ them in censuring or approving, in sincerity or flattery, for the promotion of vice or virtue. Words are sometimes solemn and sometimes gay, provocative of weeping or laughter. At one time we are startled with their roughness and harshness, at another charmed with the euphony of the syllables and the mellifluous flow of the constituent parts of the sentences. Words vary not only with the district, but with the season and climate. They are largely exclusive, associating only with relatives. Even those of

one country are, in many respects, strangers to those of another, while the aborigines of different lands have no intercourse, except in the way of exchange by literary brokers.

Words are the clothing of thought, and, like the dress of the body, there are times when they become unfashionable and lose character. They then sink in public esteem, and, like a beautiful horse, which in his prime, is valued and petted, but when the sands of life are nearly run out, is condemned to draw stones, so these become degraded and get into the hands or mouths of the vulgar. Others, however, start up in their place, and are, in their turn, much admired. On some occasions a whole race of words lose their vitality — there are none to nourish them, and so they perish through neglect — and then, as a vast army of mummies, they are by succeeding generations preserved as “a dead language.”

The soothsayer uses words as symbols of portentous meaning; the magician with mysterious signification; the medicine man and the charmer put on them a peculiar burden, and the weather prophet, with indications of “on or about.” The orator uses them with tender accents, to melt the hearts of his audience, or with force and fury to rouse them to high excitement. The poet, by their aid, gives us glowing representations of his ideals; opens to our view a paradise of flowers, or lifts us up by a golden chain to the starry pavement of the higher heavens, amid what is grand and sublime. The statesman, too, frequently, by their means, labors dark design and leads the multitude on the path of expediency, pretending is to be the high road of justice and truth. Divines, by these simple vocables, construct tomes of theology and ecclesiastical history, or, in the pulpit, —

Touch every spring and movement of the soul;
This appetite excite, and that control.

Above all, we have by their means, in the hands of the chronicler, the past world open to our view. He informs us what has been, of the peopling of countries, the rise and fall of empires, the terrible results of war, and the beneficent effects of peace — the one changing a fruitful land into a desert, the other making it blossom as the rose. Hence, it is seen, how useful is language; without words there would be darkness and vacuity; with them there is glorious light and fulness of knowledge.

It has been said that thoughts without words are nothing. But this is hardly so. On beholding, for example, for the first time, the system of Saturn through a powerful telescope, or in listening to the

almost unearthly music of a grand orchestra, a person may be induced to express his feelings in audible words, or the effect on his senses may, for the moment, be so enrapturing as to seal his lips. An infant has thoughts without words, and so has an ant, and a well known domestic animal. In fact the possession of thought without language by brutes, and of both by men, constitutes one great distinction between the two classes. The will to act and muscular action are so clearly connected, that we almost imagine them to be inseparable; but these, as well as thought and the symbols of thought, are perfectly distinct.

Symbolism, which in its broadest sense includes allegory and parable, is a species of language which was much used by the ancients. The Ægyptians, Babylonians, Peruvians, Mexicans and other nations employed it largely in their hieroglyphics and the like, much as we do language in our printed books. Indeed a disposition to symbolism has manifested itself among all varieties of human beings, and it is gross or refined agreeably with their mental condition. The ancient Ægyptians worshiped as symbols of Deity beasts and birds, reptiles, plants etc.; generally speaking, in proportion as a people are ignorant, they are superstitious. In this case, as in that of a state of enlightenment, the majority rule and it may be anything but an illustration of *vox populi vox Dei*; while the educated, believing that some kind of religion is necessary for the counteraction of general wickedness, vice, and sedition, encourage the fiction, if such it be, with its attendant symbolism. Fire has, in all ages, been deemed a symbol of purity and majesty, and in some countries has been worshiped as a god. There might seem to be more excuse for this or for the worship of the sun, the source of light and heat to our world, than for giving divine worship to bulls, serpents, or garlic; but the truth is that neither of these is admissible nor idolatry in any way. The pyramid is understood to have been a symbol of flame, because the latter, broad at the base, terminates in a point. An inverted cone was adopted, as a symbol of number, because this, beginning with a unit enlarges as it goes upwards. On a similar principle an egg has been used as a symbol of the world and a serpent with its caudal extremity in its mouth as a symbol of the year. Allegoric, parabolic or figurative language sets forth, on the one hand, certain mental and spiritual states and conditions in man by sensible objects or sensible objective combinations, thus, for example, representing the abstract by the concrete to render them intelligible; and, on the other hand, it sets forth temporal states and conditions

as in the parable of "the man who fell among thieves" and of "the ruler who took account of his servants." In the Jewish religion symbolism was practiced on a very extensive scale, the ornamentation of the temple, ceremonies, sacrifices, priest's vestments, etc., were emblematic of divine perfections, the works of creation or human qualities. Among the Brahmins and Buddhists symbolism also prevails. The crescent is the sacred sign of the Mahometan, as the cross is that of the Christian religion. The devices of birds, beasts, fishes, etc., on shields, standards, and the like have been adopted as emblems of known or imagined characteristics, of purpose or heroic deeds. This practice of symbolization may be carried to an extreme and made so complex and obscure that the symbols would require much study to be understood; for in such case it may be a representation not of things or ideas but of seeing through a glass darkly. If a man were to write a commentary on a book and his explanations required to be explained, what would be gained by the reader?

I have said that words represent things or the relations to each other of things or ideas. Names of material objects express the individual qualities, offices, or relations of those objects; names of mental objects are borrowed from the sensible qualities of matter; and all other words without exception help to denote some category, circumstance, or mode of existence. This existence may be either of the past, present, or future, actual or hypothetical; but in one or other of these ways it must be at the root of all language; for *ex nihilo nihil fit*: as the arithmetician can not operate on mere ciphers, so language can not deal with absolute nonentities, for this simple reason that nullities can not stand in any possible relation towards each other. As M. Louis Peisse, the able translator of Sir William Hamilton's essays well observes: "Not only all knowledge but even all thought is ontological, inasmuch as every judgment, every notion, every thought has for its object an existence, actual or possible, real or ideal. Everything that is affirmed or denied is affirmed or denied respecting *being*, and *being* is what is affirmed or denied of all things. As in the reality of things beside being there is nothing, in like manner in the human mind there is not a single thought which has not being for its principle, its foundation and its object. There is, therefore, no question whether our reason can know being; for in reality it does not and can not know anything." The following remark by the same author is worthy of particular attention, as (though not made by him with reference to that point) it appears to constitute the foundation of all the true

philosophy of language. "Our knowledge," says he, "of beings is purely indirect, limited, relative; it does not reach to the beings themselves in their absolute reality and essence, but only to their accidents, their modes, their relations, their limitations, their differences, their qualities; all which are manners of conceiving and knowing, which not only do not impart to knowledge the absolute character which some persons attribute to it, but even positively exclude it. Matter (or existence the object of sensible perception) only falls within the sphere of our knowledge through its qualities; mind, only by its modifications; and these qualities and modifications are all that can be comprehended and expressed in the object. The object itself, considered absolutely, remains out of the reach of all conception." The above observation we should keep in mind for the help of our understanding, in all our speculations on the nature of language. We are incapable of knowing any aggregate, particle, or modification of matter as it is in itself; we only know it in its relations of similarity, diversity, or whatever else the relations may be to the other objects of our perceptions; and as we *know relations only* it follows that they make up the whole of what we *think of* or *talk about*, and, further, no words are in their origin of concrete signification; all indicate phenomena which have no distinct, independent existence, but only a relative one.

The relations in which the objects of our senses stand toward each other are, of course, manifold and various, infinitely so. They are, for instance, near or distant, like or unlike, higher or lower, better or worse, united or separate, aggregated, segregated, or differentiated, or in any conceivable degree of affinity, or non-affinity of likeness or disparity. Now, of objects so related to each other, the word descriptive of that relation may become the name by which any one of them is popularly appellated. They may be characterized from what they do, or do not do to each other, or from any possible shade of resemblance, dissimilarity, or contrast. The most obvious relations are most likely to be fixed upon; but this is not necessarily the case; a terrestrial object, for instance, might receive its name from the sun, the moon, or the pleiades, if any relation, real or supposed, could be traced between them; and a celestial object from a terrestrial, as the Great and Little Bear, Charles' Wain, the sword and club of Orion, etc. Either term of the relation may acquire its appellation from the other. Supposing A. and B. to be considered in reference to each other, then A. might be designated from some phenomena connected with B. or *vice versa*; or either of them might be character-

ized from something derived mediately through A. and B. from C. or D. In scholastic language such names may be either *subjective* or *objective*, a point which, though hitherto greatly overlooked, is of importance in the analysis of language.

For example, the Icelandic lyckill, a key, is derived naturally enough from lyckia, to shut or lock; and the German schleussel, from schleissen (the Greek *Κλῆσις*), the Gaelic eochair, from root each, in the sense of lock or bolt, with many other terms in various languages follow the same analogy. But a key may be employed to open as well as to shut, and, therefore, it is with equal propriety in Welsh called agorad, from agori, to open. In other languages it is named from terms implying crookedness, from its usual form; and it might be equally denominated from the ideas of access, prohibition, security, confinement, or any other notion connected directly or indirectly with a key or its use. Not only philologists, but all, more or less, know how easily the words bad and good may be applied to the same object, not only in different languages, but in the same language. But there is, perhaps, no more remarkable instance of the intrinsically relative nature of words than the points of the compass, as named in certain classes of languages. Most men know that these points vary according to locality, and that the north of Moscow, for example, is not the north of New York. Men would, however, suppose that with reference to a fixed point, Greenwich Observatory, for instance, the terms designating the cardinal points could not, with propriety, interchange with each other. This may be true as to the Teutonic languages, but there are tongues in which, paradoxical as it may appear, any given point might be designated by the name of any other. In the Semitic languages, and, to a great extent, in the Celtic, east, west, north, south, are respectively equivalent to *before*, *behind*, *left*, *right*. The propriety of the appellations depend, evidently, upon the ancient practice of directing the view toward the rising sun, specifically for devotional purposes. But as there was no natural necessity of taking this precise point of view and no other, the particular directions fixed upon might just as easily have been the setting sun, the meridian, or the north pole. In the first case every present designation would have been completely reversed; the east would have become the west, the south, north, and so of the rest. In the second case all the points would have shifted ninety degrees sunwards. In the third they would have made a similar move in the opposite direction. Thus, all might travel in just stages around the horizon, and four different Semitic or Celtic tribes might have come to employ

the same set of words in four perfectly distinct acceptations. This is not mere theory, but has to a certain extent been realized in practice. In Mosblech's *Vocabulaire Francaise-Oceanien*, Article, Nord, the following passage occurs: "The islanders (Marquesans, Hawaiians, etc.), turn to the west in order to find the cardinal points; whence it comes to pass that they call the north right side, and the south left side." An inspection of the comparative table in Humboldt and Buschman's work, "*Über die Kawi-Sprache*," will confirm the accuracy of this statement with respect to various tribes of Polynesians, western as well as eastern. When an Arab visits Java he turns in the same direction as does a Javanese to look at the Southern Cross; but if asked to express this direction in words, the Arab will say that it is right (*yemen*), and the Javanese left (*kidul*). In like manner, in watching for omens, the Roman augur faced toward the south; the Greek toward the north; consequently the left (*laeva*) of the former was the eastern quarter, while the left (*ἀριστερά*) of the latter was the directly opposite, or western quarter. Thus, while each looked toward the east for auspicious omens, they denoted them by names of a diametrically opposite import. The Anglo-Saxons called the right hand "*se swidhre*," the stronger or better hand, while the Greek *ἀριστερά*, also meaning the better, was applied to the left.

The Saxon simply meant to express physical superiority, while the more superstitious Greek, both in this case and in that of the synonymous term, *εὐώρομος*, strove to avoid words of inauspicious import. Thus we find, in point of fact, the word left to have been employed by different races to denote east, west, north, south, and that the simple relation itself may be and is expressed in one language by terms which, in another, have a totally different meaning.

The above examples, given in the latter part of this discourse, which might be augmented indefinitely, will help to illustrate the positions I have advanced, namely, that words represent things and their relations, or, which is the same, ideas and their relations, being concerned with matter only as to its qualities, and mind only as to its states and modifications, and that they may be and actually are used arbitrarily and in opposite senses in different localities by different races. This position, with the phenomena of human language in general, strengthens our other position of the original creation of man as man, with his historically known characteristics of reason and speech, as against the theory of his ascent to his present position through different species of being. But all this has, I think, now been abundantly proved by the arguments

positive and negative drawn from the nature of the general subject, and for a concise view of the subject of human language itself as to its classes, formation, construction of alphabets, etc., I refer you to the last article in this volume.

A CONTEMPLATION OF VARIED SCENES AND OBJECTS OF NATURE INTENDED TO SPECIFICALLY ILLUSTRATE THE TERRESTRIAL EXISTENCES AND TO EXALT OUR CONCEPTIONS OF THE CHARACTER OF THE DEITY, IN WHICH CHAPTER WILL BE ILLUSTRATED THE INFINITY OF IDEAS WHICH ALWAYS EXISTED IN THE CREATOR'S MIND FROM A CONSIDERATION OF THE DIVERSIFIED DISPLAY OF CREATED OBJECTS IN THE ANIMAL, VEGETABLE AND MINERAL KINGDOMS OF THE EARTH.

The Cosmos we have around us, with all its varied objects and their adaptations and arrangements, may be called the Book of Nature. That book, which on its every page speaks of its Author in silent but expressive language and declares His wisdom and power, should be especially worthy of the contemplation and study of men. But although there is no speech or language in which his voice is not heard, yet how gross and inadequate are the conceptions generally entertained of that Being in whom we live and move and by whose power all events in nature are directed and controlled. The benevolence of the Deity is seen not only in the sunshine and the shower, but in the ample provision which is made on the earth for the wants of man and all other animals. Some fifty years ago it had been ascertained that more than 60,000 species of animals inhabited the air, the earth, and the waters; and it was supposed that many more thousand species existed, which had not, up to that time, come within the observation of naturalists. Since then, naturalists, by their discoveries, have, doubtless, added largely to the number of known species, and they may still go on discovering, and be able only to make near approaches to the real number existing in the earth and in connection with it, a number which it does not seem they will ever be able definitely to learn. On the earth's surface there is not a patch of ground or a portion of water, a single shrub, tree, herb or plant, nor a single leaf of a tree or flower, but what teems with animated or sensitive beings. What countless millions even of visible animals have their dwellings in caves, in the clefts of rocks, in the bark of trees, in ditches and fences, in marshes, in the forests, the mountains and the valleys. What innumerable shoals of fishes, of various sizes and appearances,

inhabit the ocean and sport in the seas and rivers. What millions on millions of birds and flying insects, in endless variety, wing their flight through the atmosphere above and around us! Besides these there are innumerable multitudes of animated beings, invisible to the unassisted eye, and dispersed through every region of the earth, air, and seas. In a small stagnant pool which, in summer, appears sheeted over with a green scum, there are more microscopic animalcules than would outnumber all the human inhabitants of the earth. How immensely great then must be the collective number of these creatures throughout all the regions of the earth and atmosphere! It utterly surpasses the limits of our conceptions. Now, it is a fact that, from the elephant to the mite, from the whale to the clam, and from the ostrich to the gnat or the microscopic animalcule, no animal can subsist without nourishment. The species, too, require various kinds of food; some live on grass, some on shrubs, some on flowers, and some on trees; some feed only on the roots of vegetables, some on the stalks or stems, some on the leaves, some on the fruit, some on the seed, some on the whole plant, and some, as we have shown before from Linnæus, with respect to quadrupeds, prefer one species of grass or vegetables, some another. Yet such is the boundless munificence of the Creator, that all these countless myriads of sentient beings are amply provided for in nature. The eyes of all these sentient beings look unto the Creator, and he openeth His hand, and satisfieth the desire of every living being. The world is so arranged that every place affords the proper food for all the living creatures with which it is inhabited. They are furnished with every organ and apparatus for the gathering, preparing, and digesting of their food, and are endowed with admirable sagacity in finding out and providing their nourishment, and enabling them to distinguish between what is salutary and what is pernicious. In the exercise of these faculties, and in all their motions, they appear to enjoy a happiness suitable to their nature. The young of all animals in the exercise of their incipient faculties, the fishes sporting in the water, the birds skimming through the air or warbling in the thickets, the gamesome cattle browsing in the pastures, the wild beasts bounding through the forests, the insects gliding through the air and crawling along the ground, and even the earth-worms wriggling in the dust, all proclaim by the vivacity of their movements and their various tones and gesticulations, that they are not without enjoyment in the exercise of their powers. In this boundless scene of animate existence we see a striking illustration of the truth of the statements: "Jehovah is good to all," "the earth is full of His riches," and "His tender mercies are over all His works." Although such dis-

plays of adaptation in animate creatures to their circumstances, and in the arrangements for their wants and enjoyments, are obvious evidences of benevolence in the Deity to a reflecting mind, yet they are almost entirely overlooked by the bulk of mankind, owing to their ignorance of the facts of natural history, and the inconsiderateness with which they are accustomed to view the objects of the visible creation. Hence they are incapable of appreciating the beneficence of the character of the Deity, and the wealth of his munificence, and unable to feel those emotions of admiration which an enlightened contemplation of the scenes of nature are calculated to inspire.

As the conceptions existing in the mind of an artificer are known by the work he produces, or the operations he performs, so the ideas which have eternally * existed in the Creator's mind may be known from the objects He creates, the events He brings about, and the operations He is incessantly conducting. The production of a single object is an exhibition of the idea existing in the creative mind of which it is a copy. The production of a second or third object exactly resembling the first would only exhibit the same idea a second or a third time without disclosing anything new concerning the producer; and, consequently, our conceptions of His intelligence would not be enlarged though millions of such objects were presented to our view, just as a hundred pairs of spectacles or a hundred microscopes of exactly the same pattern, constructed by the same artist, give us no higher idea of his skill and ingenuity than the construction of one. But every variety in the objects and arrangements of nature exhibits a new discovery of the contrivances, the intelligence, and the multiplicity of ideas of the Creator; and these varieties, as the Creator, are infinite.

* That this infinity of ideas always existed in the Creator's mind is necessarily certain from the fact of the infinite and eternal omnipresence of the Creator, which necessitates that these ideas could not arise to him from any other source than from himself. The Creator alone is eternal; all created things have a beginning and an end in time and space. We may also understand the Creator to be personal and absolute as well as infinite, although we cannot conceive of him as either of these or as anything. It cannot be said that the idea or ideas implied in the created thing arose to the Creator from the thing created any more than a picture can exist without an original existing of which it is a copy. All created things are merely copies of ideas pre-existing in the Creator's mind. This general idea of creating things refers to all the objects created on or in the earth, or in any of the heavenly bodies, or in any part of space. That the earth considered as a globe made up of solid, liquid and æriform substances, has a limit in every direction in space cannot well be doubted; and thus it is doubtless with each of the heavenly bodies, for the earth and each of them appear to perform motions and revolutions in space around each other. It is in accordance with our experience and knowledge that all things created in the animal and vegetable world have a beginning and an end in time and space; and also in the mineral world, even in the bowels of the earth, we find change taking place, one form or species of matter frequently taking the place of another in mineral existences, and to the extent that this change takes place in the mineral department of existence, to this extent there is mineral creation. Indeed the whole earth may be said to be continually in a state of change, and so it may be said to be an object of creation. So evidently it is with each of the other celestial bodies.

It is proper here to state (see also pp. 73, 74) that man is the creative agent of a world distinct from the natural world which he creates and recreates from age to age to suit his own wants; but of the world which man creates the omnipresent creator is the primal cause. Now, the word idea is, literally, an image or impression of anything, and as we know there can be no image or picture unless there be a thing of which it is a representation, so neither can there be a true idea conceived in the mind unless there is a thing of which it is an impression.* As a wheel within a wheel the moral world exists within the physical, and so each one has a world external to one's self.

We remember once being in company with some rural friends, when Bishop Berkeley's theory was mentioned, a theory which is understood to demonstrate that no external world exists, and that when one sees with his eyes any object, for example a tree, he sees not the real tree but only a picture of it on his retina. This illustration of the theory being made, one of the company expressed himself as follows: "Well, I guess, if he bumped his head against it, he would find out whether it was a tree or only an idea." Even so the readers may always feel assured that a world exists external to themselves in which they as creatures live and move. And each human being has his own ideas of and concerning the world. This external world you realize in every man and every object you behold. The martyr at the stake, or on the cross, realizes it in those who are cruelly depriving him of life. The convicted person in the court or on the scaffold realizes it by all he sees around him. And both opposing parties in the terrible bayonet charge realize mutually this great fact. Let no one by sophistry or plausible talk impose upon you to such a degree as to cause you to believe that a shadow can exist without a substance, or that true ideas can exist in the mind without the real things existing of which they are the pictures, even so the Deity is everywhere present a great reality.† You can appreciate his presence and character in all the objects and operations of nature; nor can sophistry or plausible words, spun out to any extent, make the Deity other than that great and omnipresent reality the Deity is. You should ever remember that your duty is to be good and to do good before him, worshipping him who is invisible alone in spirit and in truth.

The young (yea, and the old) should always remember, that while studying, either from books or from nature, it is very important to acquire full and distinct ideas in their mind of the subject of their

* Ideas which do not represent real things are fictitious, creations of the imagination.

† Bp. Berkeley's argument as set forth in his "Principles of Human Knowledge" is in brief: That there is no world external to the mind, soul or self; the *esse* is *percipi*. This with him is true of all the objects of the senses even of the human body and the Cosmos, so that the whole is, so to speak, only a bundle of ideas or sensations. Motion he cannot conceive as absolute. The idea of space and relative motion exists only with that of body. Thus, he leaves the world as it is phenomenally, but it really exists only in conscious thinking and willing spirits

study; for as true ideas cannot exist without the real things existing, of which they are but the pictures or shadows, even so a proper and well connected discourse on any subject cannot be produced unless the distinct ideas exist in the mind before, of which the discourse is but a representation. Ideas are representations of things, and words are representations of ideas; and words spoken inconsiderately, and at random, which are not the representations of true and well defined ideas, are as chaff blown away by the wind; they produce no proper effect, and are better left unspoken. The young and old should endeavor to have full, and true, and well defined ideas of things, and having these they will acquire, with comparative ease, words to express them.

Now in the universe, we find all things constructed and arranged on the plan of boundless variety. In the animal kingdom, as we have already remarked, there had been ascertained some fifty years ago, sixty thousand different species of animate beings. These were enumerated as follows: Six hundred species of mamalia, or animals that suckle their young, most of which are quadrupeds; four thousand species of birds; three thousand species of fishes; seven hundred species of reptiles, and forty-four thousand species of insects. about three thousand species of shell-fish; and besides these there were perhaps one hundred thousand species of animalcules invisible to the naked eye, which the microscope had brought to view, and new species daily discovering in consequence of the zeal and industry of the lovers of Natural History. We cannot set any definite limits to the number of animate beings existing in the earth, which has never yet been thoroughly explored, and never can be.

We may next consider that the organized structure of each species consists of an immense number of parts, and that all the species are endlessly diversified, differing from each other in their forms, organs, members, faculties, and motions. They are of all shapes and sizes, from the microscopic animalculum, ten thousand times less than a mite, to the elephant and the whale. They are different in regard to the construction of their sensitive organs. In regard to the eye, some have that organ placed in front so as to look directly forward, as in man. The human eye is so constructed by means of muscular bands attached to it as to be able to move up or down, to the right side or to the left, without the head being moved. This, you see, is a very convenient arrangement indicating benevolent design in the Creator. Other animals, as birds, deer, hares, and conies, have this organ so placed toward the side of the head as to take in nearly a whole hem

under control of one omnipresent, all-wise spirit, i.e., God. Being able to form no idea of spirit, the cause of ideas, he attempts not to explain it. I may add that Hegel's omnipresent God attains to consciousness only in man. Was I, then, the rushing and mighty πνευμα, which, subordinating everything in its course, elevated me from stage to stage to the third heaven (on which last stage I had a wonderful and delightful experience) during one whole night in the year 1865 in which I did not sleep, but am sure retained consciousness throughout? This I now know to have foreshown my life on earth with, it may be, a foretaste of the future. See 1st Cor. iii. 16 17. Luke xvii. 21. Also pp. 233, 237, vol. II. of this work.

isphere. This is a convenient arrangement for them, as it enables them to see their pursuers behind them, without turning the head. Some have this organ fixed, and others moveable: some have two globes or balls, as man and quadrupeds; some have four, as snails, which are fixed in their horns; some have eight, set like a locket of diamonds, as spiders; some have several hundreds, as flies and beetles, and others have over twenty thousand, as the dragon-fly, and several species of butterflies.*

In regard to the ear, some have it large erect and open, as in man and the hare, so as to hear the least noise and avoid danger; in some it is covered to keep out noxious bodies; and in others, as the mole, it is lodged deep and backward in the head, fenced and guarded from external injuries. With regard to their clothing, some have their bodies covered with hair, as quadrupeds; some with feathers, as birds; some with scales as fishes; some with shells, as the tortoise; some only with skin, as some serpents and eels: some with stout

* The eyes of beetles, silk-worms, flies, and several other kinds of insects are among the most admirable productions of the Creator. On the head of a fly are two large protuberances corresponding to the two eyes in other animals, one on each side; these constitute its organs of vision. The whole surface of these protuberances is covered with a multitude of small hemispheres, placed with the greatest regularity in rows, crossing each other in a kind of lattice work. These little hemispheres have each a minute, transparent, convex lens in the middle, each of which has a distinct branch of the optic nerve ministering to it; so that the different lenses may be considered as so many distinct eyes; Mr. Leeuwenhoek counted 6236 in the two eyes of a silk-worm, when in its fly-state; 3180 in each eye of a beetle; and 8000 in the two eyes of the common fly. Mr. Hooke reckoned 14,000 in the eyes of a drone-fly; and in one of the eyes of a dragon-fly there have been reckoned 13,500 of these lenses, and consequently in both eyes, 27,000, every one of which is capable of forming a distinct image of any object, in the same manner as a common convex glass; so that there are 27,000 images formed on the retina of this little animal. Mr. Leeuwenhoek, having prepared the eye of a fly for that purpose placed it a little farther from his microscope than when he would examine an object, so as to have a proper focal distance between it and the lens of his microscope; and then looked through both, in the manner of a telescope, at the steeple of a church, which was 299 feet high, and 750 feet distant, and could plainly see through every little lens the whole steeple, inverted, though not larger than the point of a fine needle; and then directing it to a neighbouring house saw through many of the little hemispheres, not only the front of the house, but also the doors and windows, and could discover distinctly whether the doors were open or shut. Such an exquisite piece of mechanism transcends all human comprehension.

The eyes of a fly are very large, when compared with the size of the head. If one of these compound eyes be examined under a glass with a linear, magnifying power of 100, the organ will be found to consist of many thousand tubes, each fixed in a six-sided case. Every one of these eyelets appears to be a perfect, simple eye, resembling in all essentials that of a man. Dr. Hooke gave the number of eyelets in each eye at 7,000, and Dr. Carpenter estimates them at 4,000. Thus at the lowest computation, a common house-fly possesses 8000 separate organs of vision.

The eyes of all insects are compound. The eye of a butter-fly contains in reality about 17,000 eyelets, giving to this gaudy insect 34,000 in all. Each eyelet is a perfect organ in itself, hexagonal, or six-sided, in shape, so that the whole collection resembles the cells in a large honeycomb. Some of these insects have also two simple eyes on the top of the head, so that we must confess ourselves to be altogether inferior in the matter of eyes to the gaudy butterfly. It must not be supposed that when a butterfly looks upon a female of his own species he sees 34,000 fluttering beauties before him. As the two human eyes do not double objects, so the numerous lenses of the butterfly may combine to form but one image.

and firm armor, as the rhinoceros and crocodile ; and others with prickles, as the hedgehog and porcupine ; all nicely adapted to the nature of the animal, and the element in which it lives. These coverings too 'are adorned with diversified beauties, as appears in the plumage of birds, the feathers of the peacock, the scales of fishes, the hair of quadrupeds, and the variegated polish and coloring of the tropical shell-fish, beauties, which, in respect of symmetry, polish, texture, variety and exquisite coloring, defeat every attempt of human art to imitate or copy. In regard to respiration, some breathe through the mouth by means of lungs, as men and quadrupeds : some by means of gills, as fishes ; and some, during the early part of their life, as the frog, breathe by means of gills, and in a more advanced stage of it they acquire lungs and breathe by means of them : and some breathe by organs placed in other parts of their bodies, as insects. In regard to the circulation of the blood, some have but one ventricle in the heart, some two, and others three. In some animals, as man, the heart propels the blood to the remotest part of the system : in some it throws it only into the respiratory organs ; in others the blood is carried from the respiratory organs, by means of the veins, to another heart, and this second heart distributes the blood by the channels of its arteries to the several parts.

In many insects a number of hearts are placed at intervals along the circulating course, and each renews the impulse of the former, so that a continual circulation is kept up. In regard to the bodily movements, some are endowed with quick motions, others slow ; some walk on two legs, as fowls ; some on four, as dogs, some on eight, as caterpillars ; some on a hundred, as scolopendra, some on fifteen hundred and twenty feet, as one species of starfish ; and some on two thousand feet, as certain specimens of echinus ; (It is mentioned by Lyonet that these echini have 1300 horns, which they protrude and draw in at pleasure.) Some glide along with a sinuous motion on scales, as snakes and serpents ; some skim through the air, one species on two wings, another on four ; and some convey themselves in speed and safety by means of their webs, as spiders ; while others glide with agility through the waters by the instrumentality of their tails and fins. Some animals are distinguished for having an internal bony skeleton, as man, beasts, birds, and fishes, thence called vertebrate ; some for having an external bony skeleton jointed at intervals as the lobster and insects, and thence called articulate ; some for living in horny houses, as shell-fish, turtles, and land-snails, and thence called crustaceous, and molluscous. Some live fixed like plants at the bottom of the sea, as the hydra. This animal, for example, produces young not only from eggs in the ordi-

nary way, but also by putting forth buds from its sides, which while attached to the parent develop mouths and arms, and then become separated; and having become fixed in their turn they live for themselves. The animals called crinoids grow like plants in the seas of the Tropics. The sponge also is a plant animal which lives fixed at the bottom of the sea. These sponge-plant animals, are of various forms, some of them corresponding to our moorland moss-tufts; some to the most elegant types of flower form, and some resembling in miniature the great candelabra-formed berus of the Gila regions. Most people have seen and used the sponge sold in our stores, which is merely part of the skeleton of these plant-animals. The great coral islands of the Pacific Ocean are merely aggregations of animal developments. The coral is the solid parts of the animal, composed of carbonate of lime, and corresponds, as does the sponge, to the bony skeleton in higher animals. Corals are of different forms, sometimes having the form of trees and shrubs, and sometimes a round form, as the brain stone. You have therefore in these plant-animals, which are developed in great variety and to vast extent in the seas and oceans the connecting link between the animal and vegetable and mineral kingdoms.

But it would require volumes to enumerate and explain all the varieties and peculiarities which distinguish the different species of animated beings. Besides the varieties which distinguish the species from each other, there are not, perhaps, of all the hundreds of millions of individuals which compose any one species, two individuals exactly alike in every point of view in which they may be contemplated. As an example of the numerous parts and functions which enter into the construction of an animal frame, we may state that in the human body there are about 254 bones, each of them having about forty different intentions, or adaptations; and 443 muscles, each having ten several intentions, so that the system of bones and muscles alone comprises about 14,620 varieties or different scopes and intentions. But, besides the bones and muscles, there are hundreds of tendons and ligaments for the purpose of connecting them together; hundreds of nerves ramified over the whole body to convey sensation to all its parts. The nerves have their centres in the brain and spinal marrow, whence ramifications proceed to all parts of the body. Nerve is derived from the Latin, and means cord; and the nerves, though infinitely fine cords, may, for the sake of illustration, be compared to telegraph-wires, which communicate their messages *instantly* to their centres, and thence to all parts of the system. The human being has five senses: sight, hearing, touch or feeling, taste and smell, each of these has its peculiar set of nerves;

and not only that, but the nerves are so closely reticulated over the whole body that you cannot prick it in any place with the point of the finest needle without affecting numbers of them. The senses, then, are the channels through which the sensitive or animate being communicates with the external world; by which the rational being knows that it exists and that he exists. There are thousands of arteries to convey the blood to the remotest extremities of the system, and thousands of veins to bring it again to the heart; thousands of lacteal and lymphatic vessels to absorb nutriment from the food; thousands of glands to secrete humors from the blood, and of emunctories to throw them off from the system; and besides many other parts of this variegated system with which we are acquainted, there are more than sixteen hundred millions of membraneous cells or vesicles, connected with the lungs; more than two hundred thousand millions of pores in the skin, through which the perspiration is incessantly flowing; and above a thousand millions of scales which according to Leeuwenhoek, Baker, and others, compose the cuticle of outer covering of the body. We have also to take into account the compound organs of life, the numerous parts of which they consist, and the diversified functions they perform; such as the brain with its infinite number of fibres and numerous functions; the heart with its ventricles and auricles; the stomach, with its muscular coats and juices; the liver, with its lobes and glands; the spleen, with its infinity of cells and membranes; the pancreas, with its juice and numerous glands; the kidneys, with their fine capillary tubes; the intestines with all their windings and convolutions; the organs of sense, with their multifarious connections; the messentary, the gall-bladder, the ureter, the pylorus, the duodenum, the blood, the bile, the lymph, the saliva, the chyle, the hair, the nails, and the numerous other parts and substances, every one of which has diversified functions to perform.

We may also take into consideration the number of ideas included in the connection and arrangement of all these parts, and of the manner in which they are compacted into one system of small dimensions so as to allow free scope for all the intended functions. If then, for the sake of illustration, we were to suppose, in addition to the 14,620 adaptations of the bones and muscles, as stated above, that there are 10,000 veins, great and small, 10,000 arteries, 10,000 nerves, 1,000 ligaments, 4,000 lacteals and lymphatics, 100,000 glands, 1,600,000,000 vesicles in the lungs, 1,000,000,000 scales, and 200,000,000,000 pores, the amount would be 202,600,149,460 different parts and adaptations in the human body; and if all the other species were supposed to consist of a similar number of parts, though differently

organized, this number multiplied by 300,000, the supposed number of species, the product would amount to 60,780,044,838,000,000, or above sixty thousand billions, the number of distinct ideas, conceptions, or contrivances in relation to the animal world, a number of which we can have no adequate conception, and to our minds, seems to approximate to infinity; but the calculation is merely a rude approximation, and may serve to convey some idea of the endless multiplicity of conceptions which pervade the Eternal mind.

That many other tribes of animate beings have an organization no less complicated and diversified than that of man, will appear from the following statement of M. Lyonet. This celebrated naturalist wrote a treatise upon a single insect, the cossus caterpillar, which lives on the leaves of the willow, in which he has shown from the anatomy of that animal, that its structure is almost as complicated as that of the human body, and many of the parts which enter into its organization even more numerous. He has found it necessary to employ twenty figures to explain the structure of the head, which contains 228 different muscles. There are 1647 muscles in the body, and 2066 in the intestinal tube, making in all 3713 muscles, or nearly nine times the number of muscles in the human body. There are 94 principal nerves, which divide into innumerable ramifications. There are two large tracheal arteries, one at the right and the other at the left side of the insect, each of them communicating with the air by means of nine spiracula. Round each spiraculum the trachea pushes forth a great number of branches, which are again divided into smaller ones, and these subdivided and spread through the whole body of the caterpillar; they are naturally of a silver color, and make a beautiful appearance. The principal tracheal vessels divide into 1326 different branches. All this complication of delicate mechanism, with numerous other parts and organs, are compressed into a body only two inches in length.

If we direct our attention to the vegetable kingdom, we may contemplate a scene no less variegated and astonishing, than what appears in the animal world. There have already been discovered about ninety thousand species of plants, specimens of the greater part of which have been preserved in the museum of Natural History at Paris. But it is said by naturalists that the actual number in the earth and waters cannot be reckoned at less than four or five hundred thousand species; indeed the truth is that as in the animal kingdom, they can put no definitive limits to the number, for a great part of the earth they can never explore.

The observer who takes a survey of the various members of the vegetable kingdom becomes cognizant of at least one prominent dis-

inction between them. He soon perceives that while certain vegetables have flowers, others have none; or, perhaps, more correctly speaking, if the second division really possess flowers they are imperceptible. This distinction was first taken as a basis of classification by Linnæus, the Swedish naturalist; and to this extent the classification adopted by that great philosopher was strictly natural; beyond this his classification was artificial. Now taking advantage of this distinction, Linnæus termed the evident-flowering plants *phænogamous*, from a Greek word signifying *to appear*; and he designated the non-flowering or more correctly speaking the non-evident-flowering plants *Cryptogamic*, from a Greek word signifying *concealed*. In making this division of plants into flowering and non-flowering, one must greatly expand his common notions of a flower, and not restrict the appellation to those pretty floral ornaments, which become objects of attraction, and of which bouquets are made. On the contrary he must admit to the right of being regarded as a flower any floral part, however small, even though a microscope should prove necessary for its discovery. Thus, in common language we do not usually speak of the oak, the ash, the beech, the elm, etc., as being flower-bearing trees; but they are, nevertheless, and consequently belong to the first grand division of flowering, or *phænogamous*, plants. The reader may remember as a rule, to which there are no exceptions, that every member of the vegetable world which bears a fruit, and consequently seeds, belongs to the *phænogamous* division. By following the indications of this rule, we restrict the *cryptogamic*, or non-flowering plants, to the seemingly narrow limits of ferns, mushrooms, mosses, and a few others, all of which are devoid of seeds, properly so called, but are furnished with a substitute for seeds termed *sporules* or *spores*. *Sporules*, then, are, so to speak, the seeds of flowerless and, therefore, seedless plants. We have before spoken of the vegetable kingdom as being divided into the two great branches of exogenous and endogenous plants. We may here state, however, that these two branches are included within the one great division of flowering plants, and have nothing to do with the non-flowering division, which is itself confined to narrow limits of the lowest species of plants.

All plants, most probably, certainly all flowering plants, possess sexes. The flower and its appendages are the reproductive organs of the plants. Without flowers there could be no fruit; without fruit there could be no seed; and without seed, properly so called, by far the greater number of vegetables could not be multiplied. Both sexes, the male organ called stamen, upon which the pollen or fecundating dust is produced, and the female organ called pistil, in

which the fertilizing takes place, are usually contained in the same plant, in the same flower of the plant. Occasionally, however, the two sexes are on different flowers of the same plant, and sometimes on different plants. We may, therefore, properly say that the greater number of flowers contain both sexes; but occasionally, on some plants, the sexes have flowers, each sex to itself; and occasionally again the males monopolize all the flowers on one plant, and the females all the flowers on another. When the two sexes reside in two sets of flowers on the same plant, then such a plant is said to be *monœcious*, signifying "one house;" the plant, we suppose, being regarded as a house, and the flowers as chambers in the same, in which the ladies and gentlemen dwell. When, however, the males all reside in the flowers of one plant, and the females in the flowers of another, then such plants are said to be *diœcious*, or "two-housed," the reason of which is obvious. The seeds or eggs of the plants are fertilized by the pollen, a yellowish powder, from the stamen, falling on the top of the pistil, causing it to expand, and finding its way into the ovary or seed-case, situated at the bottom of the pistil; and so the seeds are fertilized and prepared to produce when placed in proper circumstances.

The function of seeds in the flowerless plants is, as we have said, performed by spores or sporules, from *σπόρος*, the Greek word for scattered seeds. This class of plants is very small when compared with the flowering; and the spores are prepared for the most part in little receptacles called sporanges or theca; from whence, when ripe, they are scattered about by the winds; the old plants dying, new ones spring up from the spores to replace them. The best known species of this cryptogamic division, are the mosses, lichens, ferns, and fungi. The fungi are said by naturalists to be a mass of reproductive matter in themselves. In these non-flowering species may be recognized the lowest in the scale of plants; just as we have seen sponges, corals, etc., to be the lowest in the scale of animals. Do not the fungi, sponges, etc., of the two kingdoms bear some resemblance to each other?

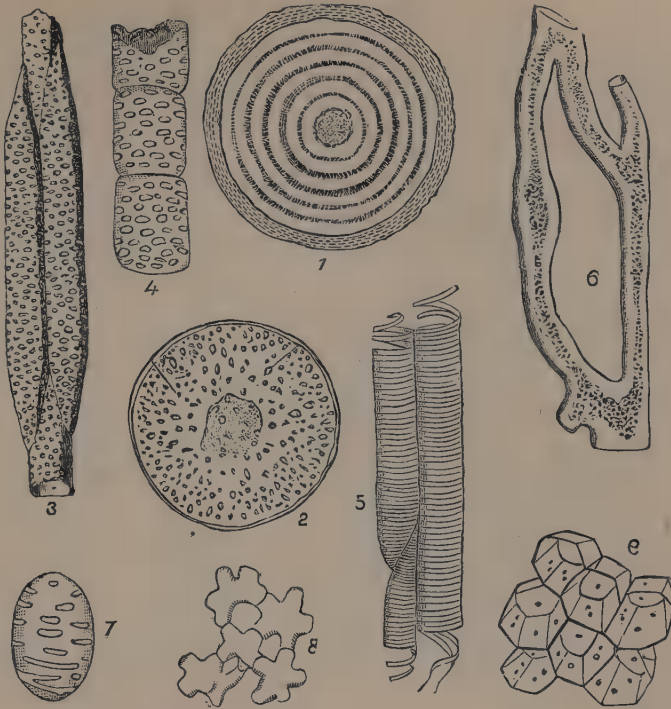
If the reader wishes to know what the sporules are like let him take the well-ripe leaf of a fern (which is not properly a leaf, but a frond); let him turn the under surface of the frond uppermost, and he will see thereon many rows of dark stripes. These are termed *Sporidia*, and they contain the spores or sporules of the plants; which latter may be obtained by opening the sporidia. These sporules, when viewed with the naked eye, look almost like dust; when examined under a microscope, however, their outline is easily recognized. The difference between a sporidium or sporule and a real seed may be

thus explained : a seed has only one part, the embryo or germ, from which the young plant can spring ; whereas a sporule does not refuse to sprout from any side which may present itself to the necessary conditions of earth and moisture. Thus, we see the resemblance of these minute seeds to the sponge, which is said to be a vast mass of reproductive matter. Although the sporules are thus easily discernible in the fern tribe, yet they are not found so easily in other members of the cryptogamic division ; in various members of which not only does their position vary, but their presence is undiscoverable by any means we possess.

Now the members of the vegetable kingdom are of all sizes, from the invisible forests, which are seen by the aid of the microscope in a piece of moldiness, to the cocoa of Malabar, fifty feet in circumference, the great dragon tree of Teneriffe, which is of such dimensions that ten full grown men joining hand to hand are scarcely sufficient to encircle its base, or the monstrous sequoia trees of California near forty feet in diameter and four hundred feet in height. Each of them great and small, is furnished with a complicated system of vessels for the circulation of its juices, the secretion of its odors, and other important functions, analogous to those in animals. Almost every vegetable consists of a root or an assemblage of roots, each of which is terminated by a number of rootlets or little tufts called spongioles, which absorb the nourishment from the soil ; a tuber or bulb, a trunk or stem, branches, leaves, skin, bark, sap-vessels, or system of arteries and veins, glandules for perspiration ; flowers made up of sepals, petals, stamens, pistils, farina, ovary or seed-case, seed, fruit, spores or sporules and various other parts ; and these are different in their construction and appearance in the different species.

Some increase, or grow, as all exogenous plants, by external depositions of their woody matter, and are distinguished, if cut in horizontal sections of the trunk, by concentric rings increasing in dimensions from the centre to the outside. See, for illustration, a horizontal section of the trunk of the oak or elm. Others, as all endogenous plants, grow by internal depositions of their woody matter, and are distinguished, if cut in horizontal section of their trunk, by the absence of pith and concentric rings ; and by the tissue, of which the stem is made up, appearing as long strings of woody fibre, and extending upwards. See, for illustration of this kind, the horizontal section of the palm tree of tropical climates, the sugarcane, the bamboo, and all the grasses.

Some vegetables, as the oak, are distinguished for their strength and hardness ; others as the elm and fir, are tall and slender ; some



1. Horizontal Section of an Exogen. 2. Horizontal Section of an Endogen. 3. Dotted Vessels of the Clematis. 4. Dotted Vessels of the Melon. 5. Spiral Vessels of the Melons. 6. Lactiferous Vessels of the Celandine. 7. Ovoid-Celi. 8. Stelliform Cells. 9. Angular Cells.

are tall, and tapering upwards to a point, as the cedar ; while others never attain to any considerable height, as the thorn-shrub ; some have a rough and uneven bark, while others, as the birch, the maple and the poplar, are smooth and fine ; some are so slight and delicate, that the least wind may bend them ; while others can resist the violence of the strongest blasts ; some acquire their full growth in a few years ; while others, as the dragon-tree, grow to a prodigious size, and stand the blasts of many centuries ; some have their branches close to the trunk ; while others, as the banyan tree, shoot them out so as to cover five acres of land, and shelter a thousand men ; some have leaves scarcely an inch in length and breadth, while others, as the tallipot of Ceylon, have leaves so large that one of them, it is said, will shelter fifteen or twenty men from the rain ; or as some of the water lilies of Central America, whose leaves, being fifteen or eighteen feet in diameter, a man may float on in safety, and whose flowers and ovary are proportionally large. Some drop their leaves in Autumn, and remain for months like blighted trunks ; while others, as the hemlock, the pine, and the holly, retain their verdure during the winter.

The variety in the vegetable kingdom as to flowers is apparent even to the most careless observer. Each species of flower differs from another in the form and hues which it exhibits. The carnation differs from the rose, the rose from the tulip, the tulip from the primrose, the auricula from the lily, the lily from the daffodil, the narcissus from the ranunculus, and the butter-cup from the daisy; while at the same time each narcissus, ranunculus, rose or daisy, has its own particular character and beauty; something peculiar to itself, and which distinguishes it from the others. In a bed of ranunculuses or tulips for example, we shall scarcely find two individuals that have precisely the same aspect, or present the same assemblage of colors. Some flowers are of stately appearance and seem to reign over their fellows in the same parterre; others are lowly, and creep along the ground; some exhibit the most dazzling colors; others of less imposing appearance blush almost unseen; some perfume the air with the most delightful fragrance, while others emit an unpleasant odor, and only please the sight with their beautiful tints. And not only do flowers differ in their forms and colors, but there is a great diversity in their perfumes also. The smell of southern wood differs from that of thyme, that of balm from that of peppermint, and that of the primrose from that of the daisy; which indicates a variety in their internal structures and in the juices which circulate within them.

As to the flower it is made up of different parts, as the calyx or under whorl, which is itself made up of several parts, called sepals; and the corolla or upper whorl, which is also made up of several parts, called petals. The calyx and corolla taken together comprise what is called the perianth, or that which surrounds and protects the reproductive part of the flower. It may be called a beautiful painted house, in which the gentlemen and ladies of the flower live. Thus, in the concave space enclosed by the perianth are found the reproductive parts of the plants; the stamens and pistils, or carpels, either or both. At the bottom of the pistil, or carpel, which means the same thing, is situated the ovary, or seed-case; the point in which it terminates above is called the stigma, and the middle part of it, the style. Upon the stigma of the pistil falls the pollen from the stamen, which causes the ovary to expand, the fruit to ripen, and the seed to grow. Thus, while the roots, with their spongioles, are called the nutritive, the flower and its appendages are called the reproductive parts of the vegetable. See annexed figures; also figures on pages 227 and 228.

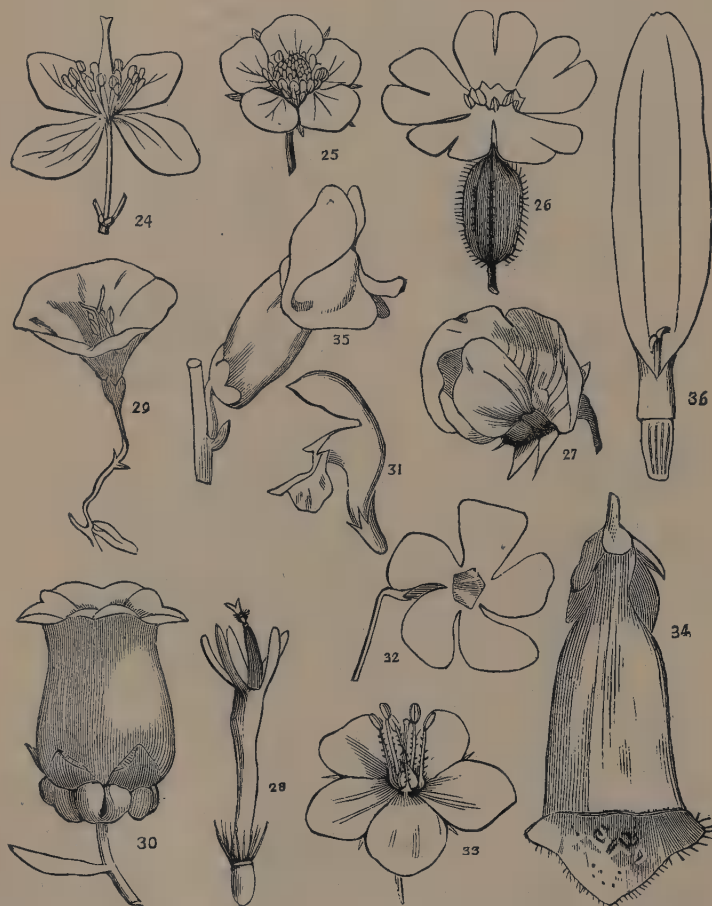
The leaves of all vegetables, like the lungs and skin of the human body, are diversified with a multitude of extremely fine ves-

sels, and an astonishing number of pores. The leaf itself consists of two flattened expansions of the epidermis, or the outer covering, called the cuticle, of the tree, the one above and the other below, enclosing between them nerves and veins, vascular and cellular tissue. The word vascular means consisting of, or containing, vessels; and cellular means consisting of cells. By vascular tissue is meant those little pipes and tubes which run through vegetables, just like arteries and veins through animal bodies, and which serve the purpose of conveying juices from one part of the plant to another. In plants, those pipes or tubes are so exceedingly small, that their tubular character is only recognized by the aid of a microscope or powerful



10. Calyx of Ranunculus. 11. Corolla of Ranunculus. 12. Stamen of Ranunculus. 13. Carpels of Ranunculus. 14. Quinquepartite Calyx of the Pimpernel. 15. Quinquefid Calyx of the Gentian. 16. Irregular Calyx of the Dead Nettle. 17. Calyx of the Madder. 18. Adherent Calyx of the Sunflower. 19. Calyx of the Dandelion. 20. Calyx of the Centranthus. 21. Calycule of the Strawberry. 22. Acorn and Cup. 23. Involucrum of the Chestnut.

lens, but their presence may be recognized in general by the naked eye. Cellular tissue is, as its name indicates, an assemblage of little cells, the natural form of which is spheroidal or oval; but more frequently this form is modified from various causes, usually the mutual pressure of the cells against each other. Thus, the pith of trees, a portion of which is made up of cellular tissue, if examined under the microscope, will be found to be composed of cells, having the form of honeycomb cells, that is, hexagonal. Occasionally the cells assume a stellate or star-like form, which may be seen in a section of the common bean, if examined under the microscope.



24. Cruciform Corolla of the Celandine. 25. Rosaceous Corolla of the Strawberry. 26. Caryophylate Corolla of the Lychnis. 27. Papilionaceous Corolla of the Pea. 28. Tubular Corolla of the Corn Centaury. 29. Infundibuliform Corolla of the Bindweed. 30. Campanulate Corolla of the Pampasula. 31. Labiate Corolla of the Dead Nettle. 32. Hypocrateriform Corolla of the Periwinkle. 33. Rotate Corolla of the Pimpernel. 34. Anomalous Corolla of the Foxglove. 35. Personate Corolla of the Snapdragon. 36. Ligulate Corolla of the Chrysanthemum.

Usually those vegetable cells are so very small that a microscope or a powerful lens is necessary for observing them. In certain vegetables, however, they are of such dimensions as to admit of being readily seen by the naked eye. For example, if the fruit of an orange be cut or pulled asunder, the cells will be readily apparent. And not only do the cells of this cellular tissue admit of being altered in form, but occasionally they give rise to parts in the vegetable



37. Pome. 38. Drupe. 39. Achæmium of the Ranunculus. 40. Caryopsis of the Buckwheat. 41. Follicle of the Columbine. 42. Capsule of the Gentian. 43. Capsule of the Corn Poppy. 44. Legume of the Lotus. 45. Capsule of the Colchicum. 46. Capsule of the Iris. 47. Siliqua of the Celandine. 48. Silicle of the Mustard Plant. 49. Samara of the Maple. 50. Nut of the Chestnut. 51. Berry of the Deadly Nightshade. 52. Capsule of the Pimpernel. 54. Germination of the Bean. 55. Germination of Indian Corn.

organization, which would not be suspected to consist of cells. The cuticle, or outer skin, of vegetables is nothing more than a layer of cells, firmly adherent; and the pith of oxogenous plants, for example, the substance which makes up the densest part of the centre of the oak is nothing more nor less than closely compressed cellular tissue. In a former illustration we have stated that the air contained in an apple can be expanded into forty-eight times the bulk of the apple; and this is because the inside of the apple is made up of little cells, each of which is filled with closely-compressed air. We have also intimated that leaves perform for vegetables the same functions in a manner that lungs do for man and land animals, and the gills for fishes. But how is this performed? We have shown that the leaves, as well as the skin, are full of cells, and tubes, and pores, just like the lungs and skin of an animal are; but they make use of that very kind of air which man and the animals refuse; they inhale carbonic acid so much of which is generated on the surface of the earth by combustion, as well as otherwise, and in animal bodies,—they retain the carbon, which the animals refuse, and reject the oxygen, which the animals retain, and which supports their life. Carbonic acid is in itself poisonous to animals, but is thus the support and nourishment of vegetables; and the latter, by using it, perform the part of purifying the air. Hence it is seen how one part of nature is adapted to the other; how each element returns to its proper place, and all things to equilibrium. In a kind of box-tree, called Palm of Ceres, it has been observed that there are over 172,000 pores on *one side* of the leaf. The whole earth is covered with vegetable life in such profusion as astonishes the contemplative mind. Not only the fertile plains, but the rugged mountains, the *most barren spots*, and even the caverns of the ocean, are diversified with plants of various kinds; and from the torrid to the frigid zones every soil and every climate has plants and flowers peculiar to itself. To attempt to estimate their number and variety would be like attempting to dive into the depths of infinity: and, therefore, we shall have to content ourselves with merely giving this interesting part of nature a passing notice, so far at least as to show its analogy and relation to the animal kingdom. Yet every diversity in the species of plants, every variety in the form and structure of individuals, and even every difference in the shade and combination of colors in flowers of the same species, exhibits a distinct conception which ever existed in the Eternal mind.

Linnæus adopted the following pithy designation for minerals, vegetables and animals: “Minerals,” he said, “grow; plants grow and live; but animals grow, live and feel.” An expression which indeed, if insufficient is not unjust. We may say more distinctively,

however, that animals are those living beings which derive their nutriment from an internal cavity, the stomach; and vegetables are those living beings which derive their nutriment from without.

If we should take a survey of the mineral kingdom we should also behold a striking expression of the manifold wisdom and the power of Deity. It is true we cannot penetrate into the bowels of the earth so as to ascertain the substances which exist and the processes which are going on near its central regions. But within a short distance of its surface we find such an astonishing variety of mineral substances as clearly shows that its internal parts are constructed on the same plan of variety as characterizes the animal and vegetable kingdoms. In the classes of *earthy*, *saline*, *inflammable*, and *metallic fossils*, under which mineralogists have arranged the substances of the mineral kingdom, are contained an immense number of genera and species. Under the *earthy* class of fossils are comprehended diamonds, chrysolites, menillites, garnets, zeolites, corundums, agates, jaspers, opals, pearl-stones, tripoli, clay-slate, basalt, lava, chalk, limestone, ceylenite, strontium, barytes, celestine, and various other substances. The *saline* class comprehends such substances as the following: natron or natural soda, rock-salt, nitre, alum, sal-ammoniac, epsom-salts, etc. The class of *inflammable* substances comprehends sulphur, carbon, bitumen, coal, amber, charcoal, naphtha, petroleum, asphalt, caoutchouc, mineral-tar, etc. The *metallic* class comprehends iridium, platina, gold, mercury, silver, iron, lead, tin, bismuth, zinc, antimony, cobalt, nickel, manganese, magnesium, molybdenum, arsenic, scheele, menachanite, uran, silvan, chromium, tungsten, uranium, titanium, tellurium, sodium, potassium, etc. All these mineral substances are distinguished by many species and varieties. There are reckoned eight genera of earthy fossils. One of these genera, the flint, contains thirty-four species; and these species are distinguished by numerous varieties, such as crysoberyls, topazes, agates, beryls, quartz, emery, diamond, spar, etc. Another genus, the clay, contains thirty-two species, such as opal, pitch-stone, felspar, black-chalk, mica, horne-blende, etc. And another genus, the calc, contains twenty species, as limestone, chalk, slate, spar, fluor, marle, boracite, loam, etc. There are ten species of silver, five of mercury, seventeen of copper, fourteen of iron, ten of lead, six of antimony, three of bismuth, etc. All these mineral bodies present differences as to figure, transparency, hardness, lustre, ductility, malleability, texture, structure, sound, smell, taste, weight, and their magnetical and electrical properties; and they exhibit almost every variety of color. As to structure, a body may be brittle, sectile, or separating in layers, malleable, flexible and elastic. A mineral can only affect the taste

which is soluble in the saliva, and is saline, alkaline, or astringent. Dependent upon light are five characteristics of minerals, color, lustre, diaphaneity, refraction and fluorescence. Color is either metallic or non-metallic. Metallic lustre is that peculiar lustre which distinguishes the metals, although it does not belong exclusively to them; for graphite, which is carbon, and the scales of iodine both possess metallic lustre. Minerals whose color is non-metallic may be found of every hue, from the black onyx to the colorless diamond. The colors which distinguish all other objects are non-metallic. The degrees of lustre are five: splendent, shining, glistening, glimmering, dull, which expresses the absence of lustre. The degrees of diaphaneity are five: transparent, semi-transparent, translucent, translucent on the edges, opaque, when no light passes through, etc. Some of these substances are soft and pulverable, and serve as a bed for the nourishment of vegetables, as black earth, chalk, clay and marle. Some are solid, as iron and silver; and some are fluid, as mercury, sodium, and potassium. Some are brittle, as antimony and bismuth; and some are malleable, as gold and zinc; some are subject to the attraction of the magnet; others are conductors of electricity; some are easily fusible by heat; others will resist the strongest heat of our common fires. Some are extremely ductile, as platina, which has been drawn out into wires less than the two-thousandth part of an inch in diameter; and gold, the parts of which are so fine and expansible, that an ounce of it is sufficient to gild a silver wire more than 1300 miles long.

To have the opportunity of acquiring the most ample and impressive idea of the mineral kingdom one should visit an extensive mineralogical museum, where he will have ocular evidence of the great beauty and the endless variety which this department of nature exhibits. Here it may also be remarked that not only the external aspect of minerals, but also the interior configuration of many of them presents innumerable beauties and varieties. A rough, dark-looking pebble, which to an incurious eye appears only like a fragment of common rock, when cut asunder and polished presents an assemblage of the finest veins and most brilliant colors. Marble workers have daily experience of this in the rough blocks of California and other marble, as well as of granite and other stone, which they reduce to such smoothness and beauty by their art. If one goes into a lapidary's shop which is furnished on an extensive scale, and takes a leisurely survey of his jaspers, topazes, cornelians, agates, garnets, and other stones, he cannot fail to be struck with admiration, not only at the exquisite polish and the delicate wavings which their surfaces present, but at the variety of coloring and design exhibited, even by

individuals of the same species ; the latent beauties and diversities of which require the aid of the microscope to discern, and are beyond the efforts of the most delicate pencil to imitate.

And not only in the objects which are visible to the naked eye is the characteristic of variety to be seen, but also in those which can only be discerned by the aid of the microscope. In the scales of fishes, for example, we perceive an infinite number of diversified specimens of the most curious productions. Some of these are of an extended form, some round, some triangular, some square, in short of all imaginable variety of shapes. Some are furnished with sharp prickles, as in the perch and sole ; some have smooth edges as in the tench and eod fish,—and even in the same fish there is a considerable variety : for the scales taken from the belly, the back, the sides, the head, and other parts, are all different from each other. In the scale of a haddock we perceive one piece of delicate mechanism ; in the scale of a perch another ; and in the scale of a sole beauties different from both. We find some of them ornamented with a prodigious number of concentric flutings, too near each other and too delicate to be easily enumerated. These flutings are frequently traversed by others diverging from the centre of the scale, and proceeding from thence in a straight line to the circumference. On every fish there are many thousands of these variegated pieces of mechanism.

The hairs on the bodies of all animals are found by the microscope to be composed of a number of extremely minute tubes, each of which has a round bulbous root, by which it absorbs its proper nourishment from the adjacent humors ; and these are all different in different animals. Hairs taken from the head, the eyebrows, the beard, the nostrils, the hand, and other parts of the body, are unlike each other, both in the construction of the roots, and the hairs themselves, and appear as varied as plants of the same genus but of different species.

The parts of which the feathers of birds are composed present a beautiful diversity of the most exquisite workmanship. There is scarcely a feather but contains a million of distinct parts, every one of them of regular shape. In a small fibre of a goose quill more than 1200 downy branches, or small leaves, have been counted on each side ; and each appeared divided into sixteen or eighteen different joints. A very small part of the feather of a peacock, one-thirtieth of an inch in length, appears no less beautiful, when viewed through the microscope, than the whole feather does to the naked eye—exhibiting a multitude of bright, shining parts, reflecting first one color and then another, in the most vivid manner.

The wings of all kinds of insects, too, present an astonishing

variety, and no less captivating to the mind than pleasing to the eye. They appear strengthened and distended by the finest bones, and covered with the thinnest membranes. Some of them are adorned with neat and beautiful feathers, and many of them provided with the most symmetrical articulations and foldings for the wings when they are to be withdrawn and folded up in their cases. The thin membranes of the wings appear beautifully divaricated with thousands of little points like silver studs. The wings of some flies are filmy, as the dragon-fly; others have them stuck over with short bristles, as the flesh-fly; some have rows of feathers along their ridges, and borders round their edges, as in the gnats; some have hairs and others hooks, placed with the greatest regularity and order. In the wings of moths and butterflies there are millions of small feathers of different shapes, diversified with the greatest variety of bright and lively colors, each of them so small as to be altogether invisible to the naked eye. The leaves of all plants and flowers, when examined by the microscope, are found to be full of innumerable ramifications, corresponding to the closely interwoven network of veins on the surface of the human body, whose office is to convey the perspirable juices to the pores, and to consist of the barenchymous and ligneous fibres, interwoven in a curious and admirable manner. The smallest leaf, even one which is little more than visible to the naked eye, is found to be thus divaricated, and the variegations are different in the leaves of different vegetables. The way in which the leaves are veined is also another means, beside that of the horizontal sectional aspect of the trunk or stem, of determining the class of flowering vegetable to which their plants belong. If the veins run parallel to each other on the leaf, the plant belongs to the *endogenous* class; if they are reticulated, or interlacing each other in all directions, it belongs to the *exogenous*. Thus, referring to the leaf of the iris, you find that it is of an endogenous, or within-growing, plant; and you know by the same kind of examination that the melon is an exogenous, or without-growing, plant.

A transverse section of a plant not more than *one-fourth of an inch* in diameter, when viewed through a powerful microscope, displays such beauties as cannot be conceived without ocular inspection. The number of pores of all sizes, amounting to hundreds of thousands, which are the vessels of the plant cut asunder, the beautiful curves they assume, and the radial and circular configurations they present in endogenous plants are truly astonishing; and not only the two great classes but every distinct species of plants exhibit a different configuration. There have been counted in a small section of a plant, of the size above stated, 5000 radial lines, each containing

about 250 pores, great and small, which amount to one million two hundred and fifty thousand of these variegated apertures.

Even the particles of sand on the sea shore, and on the rivers' banks, differ as to the size, form and color of their grains; some being transparent, others opaque; some having rough, and others smooth surfaces; some are spherical or oval, and some pyramidal, conical, prismatical, or polyhedral. Mr. Hooke happening to view some grains of white sand through his microscope, hit incidentally upon one of the grains which was exactly shaped and wreathed like a shell, though it was no larger than *the point of a pin*. "It resembled," says he, "the shell of a small water-snail, and had twelve wreathings, all growing proportionately one less than another towards the middle or centre of the shell, where there was a very small, round, white spot." This gives evidence of the existence of shell-fish, which are invisible to the naked eye; and therefore *smaller* than a mite.

The variety of forms in which animal life appears, which the microscope enables us to explore, is indeed wonderful. Microscopic animals are so different from those of the larger kind, that scarcely any similarity seems to exist between them; and from a limited knowledge of them, one would be almost tempted to suppose that they live in accordance with laws directly opposite to those which preserve man and all other animals in existence. When we begin our explorations in this region of animate nature, we feel as if we were entering upon the confines of a new world, and surveying a new race of sentient existence. The number of these creatures exceeds all human calculation or conception. Many hundreds of species, all differing in their forms, habits, and motions, have already been distinguished and described; but we know that by far the greater part of the system of the earth is unexplored, and doubtless forever hid from the view of man. They are of all shapes and forms. Some of them appear like minute atoms; some like spheres or spheroides; some like hand-bells; some like wheels turning on an axis; some like double-headed monsters; some like cylinders; some have worm-like appearances; some have horns; some resemble eels; some are like long hairs, 150 times as long as they are broad; some like spires and cupolas; some like fishes; and some like animated vegetables. Some of them are almost visible to the naked eye; and some so small that the breadth of a human hair would cover fifty or a hundred of them; and others are so minute that millions on millions of them might be contained within the space of a square inch. In every pond and ditch, and in every puddle; in the infusions of pepper, straw, grass, oats, hay, and other vegetables; in paste and vinegar, and in water found in

oysters ; on almost every plant, and flower ; and in the rivers, seas, and oceans, these creatures are found in such numbers and variety, as altogether exceed our conceptions. A class of these animals, called *Medusæ*, has been found, so numerous as to discolor the ocean itself. Captain Scoresby found the number in the olive green sea to be immense. A cubic inch contained 94 ; and consequently a cubic mile would contain 23,909,000,000,000,000, or nearly 24 thousand billions ; so that if one person could count a million in seven days, it would have required that over 76,000 persons should have begun 6,000 years ago, in order to have completed the enumeration at the present time. Yet, all the minute animals to which we now allude are furnished with numerous organs of life, as well as the larger kinds. Some of their internal movements are distinctly perceived ; their motions are evidently *voluntary*, and some of them appear to be possessed of a considerable degree of sagacity, and to be fond of each others' society. It may in short be unhesitatingly affirmed that the beauties and varieties which exist in those regions of the earth which are invisible to the unassisted eye are far more numerous than what appear to a common observer in the visible domain of nature. How far this scene of creating power and intelligence may extend beyond the range of our microscopic instruments it is impossible for us to determine ; for the more perfect our glasses are, and the higher the magnifying power we apply, the more numerous and diversified are the objects which they discover to our view. And as the most perfect telescope is, and ever will be, insufficient to convey our view to the boundaries of the great universe, so we may justly conclude that the most powerful microscope that has been, or ever will be, constructed, will be altogether insufficient to guide our view to the utmost limits of the descending scale of creation.

But the knowledge we already possess of these invisible and inexplorable regions gives us an amazing conception of the wisdom and intelligence of the Creator, of the immensity of His nature, and of the infinity of ideas which during all time existed in His all-comprehensive mind. What immense space in the scale of animal life intervenes between an animal which appears only the size of a visible point, when magnified 500,000 times, and a whale a hundred feet long, and twenty broad ! The proportion of bulk between one of these beings and the other is nearly 34,560,000,000,000,000 to 1, or over thirty-four trillions and a half to one. Yet all the intermediate space is filled up with animated beings of every form and order.

A similar variety obtains in the vegetable kingdom. It has been calculated that some plants which grow on rose leaves and other

shrubs are so small that it would require more than a thousand of them to equal in bulk a single plant of moss; and if we compare a stem of moss, which is generally not above one sixtieth of an inch, with some of the large trees in Brazil and California, of twenty feet diameter, we shall find the bulk of the one to exceed that of the other, no less than 26,969,706,000,000, which, multiplied by 1,000, will produce 26,969,706,000,000,000, or nearly 27 thousand billions of times, which the large tree exceeds the roseleaf plant in size. Yet this immense interval is filled up with plants and trees of every form and size. With good reason then may we repeat the language of the Psalmist, with reference to the Deity: "How manifold are thy works, O Lord! In wisdom hast thou made them all. Marvellous things doeth He, which we cannot comprehend."

On Crystallization.

The subject of crystallization is one which is also of great interest, and in which there is great variety of forms of matter displayed. When a mineral from any cause has been deprived of its cohesion, and its particles separated, if the particles are permitted to associate themselves again to form a solid, in such a way that they can follow their own inclination, the solid will indicate its being constructed according to certain laws; that is to say, the force of cohesion operating in the new formation does not act equally in all directions, but in the great majority of cases sets itself to construct regular geometrical solids, called crystals. For illustration, if any ordinary salt, common salt, or salt-petre, or alum, be added to boiling water until the water will dissolve no more, and a bunch of threads be suspended in this solution, and allowed to stand all night, in the morning the string will be found covered all over with crystals. If common salt be used the crystals will be cubes; if alum they will be four-sided pyramids, placed base to base. The larger the quantity of solution, and the more slowly it cools, the larger will be the crystals; muddy solutions also increase their size. The presence of a substance which does not crystallize with the salts may modify the shape of the crystals; thus, if in the solution of common salt urea be present, the crystals will no longer be cubes, but, like those of alum, octahedra.

The peculiarities of crystallization are many. We might almost say that crystals in their formation exhibit signs of instinct. If a damaged crystal be suspended in a saturated solution of the salt which composes it, the salt out of the solution will begin to repair the damage, so that in a little while the general contour of the crystal will be restored. If in a solution there be small and large crys-

tals, and the solution by an alteration of temperature be made alternately saturated and non-saturated, it will be found that the small crystals become entirely dissolved, while the large crystals grow. Crystals may also be obtained from a vapor condensing; sulphur, arsenic, and iodine, afford examples of this; or from a liquid cooling. If, for example, six or eight pounds of sulphur or bismuth be melted and allowed to cool, if, when a crust has been formed on it, the crust be removed, and the yet liquid substance be poured out, the cavity of the vessel will be found lined with crystals; and often when a metal has been molten, and in its cooled state exhibits no signs of crystallization, yet the existence of the phenomenon may be shown if a weak solvent be applied to remove those particles which mask the formation. If a sheet of tin, while hot, be washed over with a weak solution of hydrochloric acid, the crystals which make the tin *moirée métallique* (or crystallized tin plate), and which previously existed, will appear. A bar of nickel, placed in dilute nitric acid, becomes covered with tetrahedra, because the acid dissolves the intervening uncrystallized metal. But, perhaps, the tendency of particles to arrange themselves in some order of polarity is most strikingly illustrated in solids which are undergoing processes which move their particles. For example the axle, or the tire of the wheel, of a railway carriage, by constant vibration occasions the particles of which it is composed to take positions according to the polarity of their kind, and the consequence is that many axles or trees, when broken after years of service, exhibit throughout their mass crystals of iron.

Very few persons out of the great mass of mankind are aware that when they are walking on snow they are treading beneath their feet the most beautiful crystals. Snow is all composed of crystals in which, though a great diversity of figure is apparent, yet all the angles are equal, being those of an equilateral



triangle, sixty degrees; and it is the angles which are the constants in crystallography; these never vary; but the faces of the same form of crystal are always equally inclined. When a flake of snow is examined by a magnifying glass, the whole of it will appear to be composed of fine shining specula, diverging like rays from a centre. Many of the snow crystals are of a regular figure, for the most part

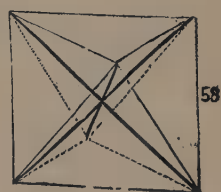
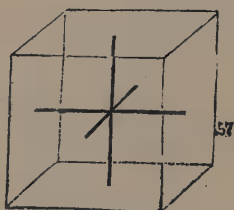
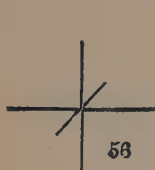
stars of six points, and are as perfect and transparent ice as any we see on a pond or river. Their forms present an almost endless variety, are often very regular and beautiful, and reflect with exceeding splendor the rays of the sun. This is the reason why snow appears white, the light being reflected from every angle and face of the infinite number of crystals. The crystals of snow vary from one third to one thirty-fourth of an inch in diameter, in the natural size. Ice, as we have had occasion to remark before, is crystallized water, just as snow is crystallized water from vapor in the air. See annexed figure.

A very slight acquaintance with crystals will assure the observer that those of the same mineral have a close relationship to each other, whenever the same forms are studied. The law of symmetry is one of the principles upon which creation is carried on. It is observable in every organic structure that about a certain plane or certain planes the structure is built up. For example, a plane passing down through the centre of the human frame would divide the body into two similar halves. So with crystals they are all arranged symmetrically about *imaginary* lines; and according to the *arrangement* of these axes of symmetry crystals are divided into six classes or systems.

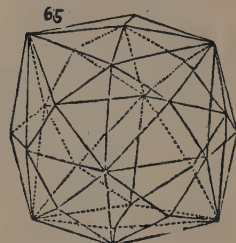
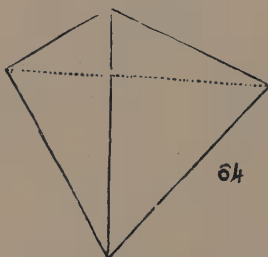
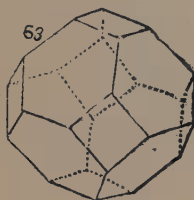
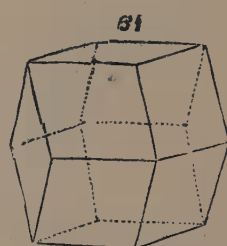
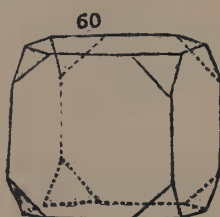
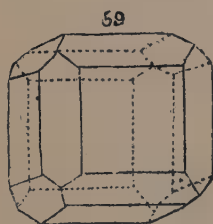
1st. The *Monometric, Regular, Tessular, or Cubic, System* has three axes of symmetry, all equal, and all at right angles to each other. About these axial lines the crystal is symmetrically built up, so that when heated it expands equally in all directions, and transmits light without refracting the rays. The primary figures of this system may be found by causing planes to pass perpendicularly through the extremities of the axis. This will produce the cube. The other prominent figure of the system, the *octahedron*, is formed by causing eight planes to pass through the three extremities of the axes. The reader will easily conceive of two tetrahedral, or four-sided, pyramids, being joined to each other base to base, which is the form of this octahedron. By combining these two primary figures in various proportions a series of crystals may be produced. It is proper here to remark that this combination we speak of is only imaginary, for all the forms of crystals are natural, and that by this imaginary combining and modifying the prominent forms of each system a series of crystals appear for each system, which are called *secondary* crystalline forms, which only means that they are forms which are scarce in the system as compared with the primary or prominent forms. The following are the forms of this system and the minerals which crystallize into it:

The tetrahedron, in which form grey copper crystallizes.

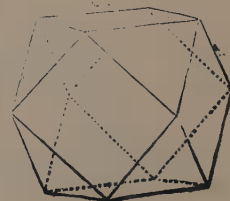
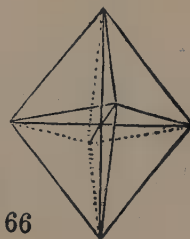
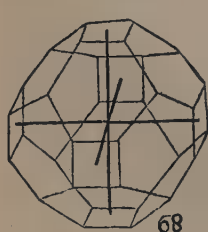
The Cube (Primary) in which form	<div> <div>Fluor Spar</div> <div>Galena</div> <div>Rock-Salt</div> <div>Iron Pyrites</div> </div>	Crystallize
The Octahedron (Primary) "	<div> <div>Alum</div> <div>Spinell</div> </div>	Crystallize
The Cube Octahedron "	Galena (ore of Lead)	"
The Rhombic Dodecahedron "	Garnet	"
The six-faced Tetrahedron "	Diamond	"
The six-faced Octahedron "	Garnet	"



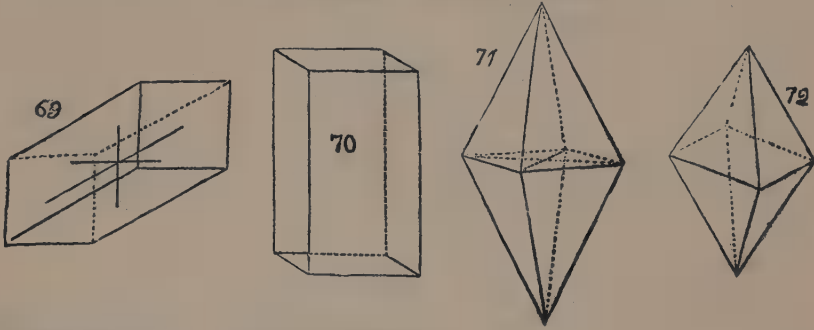
Figures 56, 57, 58 represent the primary.



Figures 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, the secondary forms of this system.



2nd class : The *Dimetric, Right Square ; Prismatic* or *Pyramidal system* has also three axes all at right angles to each other ; but one axis is longer than the other two. The prism and the double-pyramidal octahedron are the usual primary forms of this system, and it has also its secondary forms. The following minerals are known to crystallize into this system: Tinstone, ferrocyanide of Potassium, cyanide of Mercury, rutile, anatase, and idocrase.

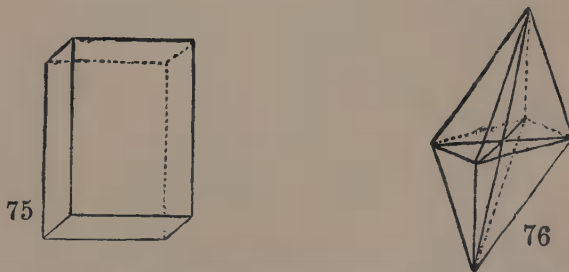


Figures 69, 70, 71, 72, represent the



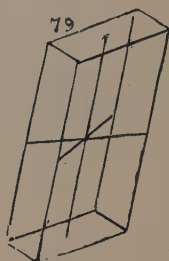
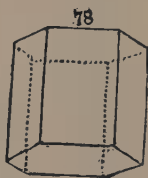
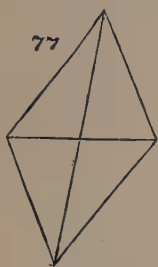
primary ; and 73, 74 the secondary forms of this system.

3rd Class : The *Trimetric, Right Rectangular, or Prismatic system*. This system has three axes all at right angles, but all unequal. The primary forms in this system are the rectangular prism, and the octahedron. It has also its secondary forms. Nitre, aragonite, topaz, sulphate of

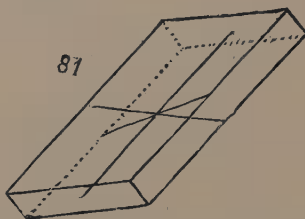
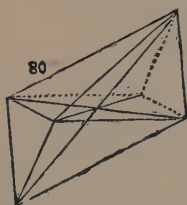


baryta, sulphur, and stilbite crystallize in this system. Figures 75, 76, represent the principal forms of this system.

4th Class: The *Monoclinic*, or *Oblique system*. The axes of this system are unequal in length, like the last; but two of them intersect each other, not at right angles. The effect of this is that the base of the prism or octahedron, which are the principal forms of this system, is a parallelogram of unequal sides. Green vitriol, sulphate of soda, phosphate of soda, sulphur, crystallized from its melted state, and borax, crystallize in this system. Figures 77, 78, 79 will give the idea of this system.



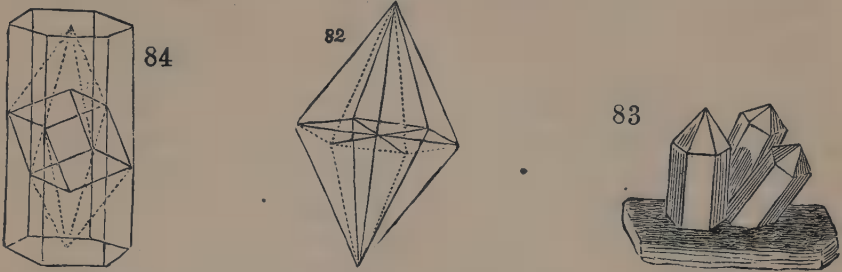
5th Class: The *Triclinic*, *Doubly Oblique*, or *Anorthic system*. This system has also three unequal axes, but none of them intersect at right angles. The prism and the octahedron are the primary forms, but these are necessarily different in form from the preceding; and there are secondary forms. But few minerals appear to crystallize, in this system. The most common are blue vitriol (sulphate



of copper), labradorite, anorthite, and aximite. Figures 80 and 81 show the octahedron and the prism of this system.

6th Class: The *Hexagonal*, and *Rhombohedral System*. The crystals of this system have four axes, three of them in the same plane and intersecting at angles of sixty degrees, and all equal; the fourth perpendicular to these, and varying in length. By the supposed joining of the extremities of these axes a hexagon is formed, which is the base of a prism (therefore six-sided), and of a hexagonal dodecahedron. These primary forms appear in snow crystals, beryl, tourmaline, and nitrate of soda, and the very common quartz crystals, which almost every one has seen, are generally six-sided prisms, terminated by six-sided pyramids. This system is also called the Rhombo-

hedral, from the fact that the rhomb, so admirably shown in calc-spar, is the hemihedral form of the hexagonal dodecahedron; that is, if the alternate faces of the double, six-sided pyramid be supposed produced, they will form a six-sided solid, which appears in figure 84. Figures 82, 83, represent the principal forms of this system.



Almost all minerals crystallize into some one of these systems. For example, gold, silver, copper, and platina are found to crystallize in the first or monometric, system. A sublime display of crystallization is seen in some places on the earth's surface. A visit to the island of Staffa, in Scotland, and to the Giant's Causeway, in Ireland, would be amply repaid to one who liked to inspect and contemplate such sublime natural wonders.

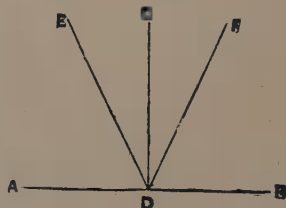
In order that some of the words which we have found it necessary to use in this short description of crystallization may be understood by all our readers, we may explain that monometric signifies having one measurement, or equal measurement, the monometric system being distinguished by equality of axes. Dimetric signifies having two measurements, crystals in this system having one longer axis and two shorter ones, which latter two are of the same length. Trimetric signifies having three measurements, the crystals of this system having three axes, all of which differ in length. Monoclinic signifies having one sloping axis, crystals of this system having one axis, which is not rectangular to the other two. Triclinic signifies having three axes at oblique angles to one another. Hexagonal signifies six-sided, or six angled. Dodecahedral signifies having twelve sides. Rhombohedral signifies having its sides in the form of a rhombus, from a figure whose four sides are equal, but its angles are not right angles.

ON LIGHT: THE PRISM, THE SPECTRUM, SPECTRAL ANALYSIS, &c.

But all this scene of beauty and all these natural wonders we have been contemplating need the agency of light to make them apparent. Light, as we have before remarked, is essential not only to the existence and growth of plants and animals, but also to the

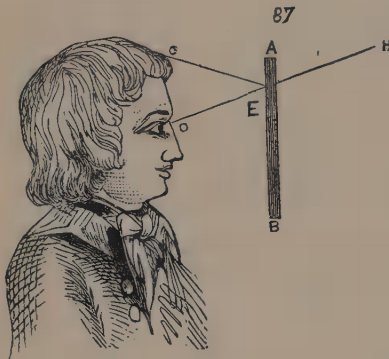
phenomena of colors. It is a manifestation of a substance which is universally present, but needs to be in certain conditions of chemical action in order that the light be made manifest. It radiates from a luminous object in straight lines in all directions, and all objects are seen by its reflection from their surfaces. The *reflection* of the rays of light is that property by which, after striking the surfaces of bodies, they are driven back or repelled. It is, therefore, in consequence of this property that all the objects around us, and all the diversified landscapes on our globe are rendered visible. When light impinges or strikes upon a surface,—say, for illustration, a polished surface, rather more than half of it is thrown back or reflected in a direction similar to that of its approach; that is to say, if it fall perpendicularly upon a surface it will be *perpendicularly reflected*; but, if it fall obliquely, it will be reflected *with the same obliquity*. Hence the following fundamental law, regarding the reflection of light has been deduced both from experiment and mathematical demonstration, namely, that *the angle of reflection is, in all cases, exactly equal to the angle of incidence*.* Thus if a ray of solar light be admitted into a dark room through a hole in the window-shutter, the ray will pass straight through to the opposite wall, and by its reflexion from the wall throw a certain amount of light round the whole room. Thus the whole room is to a certain degree lighted, although not with the direct rays of the sun. Also, if the window be not situated directly opposite to the sun, the ray of light which enters must itself be a ray of light reflected from the atmosphere, or from some outside objects. This last ray, however, when admitted, passes through as a direct ray to the opposite wall, and is again reflected. Thus it is seen that there is no end to the reflections of light, and the atmosphere during the day is one great illuminated ocean, from the fact that the solar image is reflected and refracted from every portion of it. You see your own image in a looking-glass, moreover, by the rays of light from your body being reflected; and by placing two plane mirrors in certain positions in relation to each other and to a luminous object, you can multiply the number of images of an

* Let A B represent a plane mirror, and C D a line or ray of light, perpendicular to it. Let E D be the incident ray, from any object; then D F will be the reflected ray, thrown back in the direction D F; and it will make, with the perpendicular C D, the same angle which the incident ray E D does with the same perpendicular; that is, the angle F D C is equal to the angle E D C, in all cases of obliquity; the perpendicular ray being, of course, perpendicularly reflected. The way we see our faces and our persons in a looking-glass, is illustrated by figure 87.



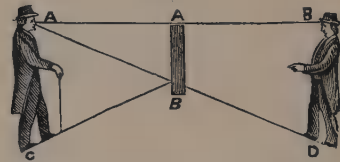
object indefinitely. In the case too of your image being reflected from a looking-glass, the angle of reflection is equal to that of incidence; for your image seems to form the same angle with the glass behind it, as you do before it; and if you change your position it changes also, and maintains the same angle as you do in relation to the glass.

While light, when proceeding from a luminous body, without being reflected from any opaque substance, or inflected by passing near one, is invariably found to proceed in straight lines, without the least deviation, yet, if it pass obliquely from one medium to another, it always deviates from its original course, and takes a new one. This change of direction, or bending of the rays of light, is what is termed *refraction*, from the Latin word *frangere*, to break or to bend. The angle of refraction depends upon the obliquity of the rays falling upon the refracting surface, being always such that the sine of the incident angle is to the sine of the refracted angle in a given proportion.* The *incident angle* is the angle made by a ray of



Let A B represent a mirror, and O C a person looking into it. If we conceive a ray, proceeding from the forehead C E, it will be reflected

Fig. 88.



to the eye at O, agreeably to the angle of incidence and reflection, but the mind puts C E O into one line, and the forehead is seen at H, as if the lines C E O had turned on a hinge at E.

It is a peculiar faculty of the mind to put two oblique lines, C E and O E, into one straight line O H; yet, it is seen every time we look at ourselves in a mirror. For the ray really strikes the mirror from C at E, and thence strikes the eye at O; and it is that journey which determines the distance of the object; and hence we see our image as far behind the mirror as we stand before it. Though a ray is here taken only from one part of the face, it may be easily conceived that rays from every part of the face must produce a similar effect.

In every plane mirror, the image is always equal to the object, at which distance soever it may be placed; and as the mirror is only at half the distance of the image from the eye, it will completely receive an image of *twice* its own length. Hence a man six feet in height may view himself completely from tip to toe in a looking-glass of three feet in height, and half his own breadth; and this will be the case at whatever distance he may stand from the mirror, as is shown in figure 88.

* For illustration of refraction: Let A D H I, fig. 89, be a body of water, A D its surface, C a point in which a ray of light, B C, enters from the air into the water. This ray, by the greater density of the water, instead of passing straight forward in its first direction to K, will be bent at the point C, and pass along in the direction C E, which is called the refracted ray. Let the line F G be drawn perpendicular to the surface of the water in C; then it is evident that

light and a line drawn perpendicular to the refracting surface, at the point where the light enters the new medium. The *refracted* angle is the angle made by the ray in the refracted medium with the same perpendicular produced. The sine of the angle is a line which serves to measure the angle, being drawn from a point in one side perpendicular to the other.

On the principle of refraction, you may, by means of a multiplying glass, see as many images of a luminous object as the glass has different surfaces. If the multiplying glass have twenty different surfaces, you see twenty different images; or, if the surfaces could be cut and polished so small that it has five hundred surfaces then you see five hundred images of the same luminous object. Thus, it is seen, the light of a given luminous object will be the more diffused, the more surfaces there

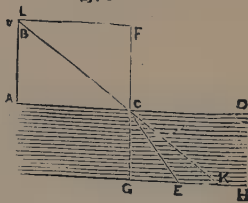
the ray B C, in passing out of the air, a *rare* medium, into a *dense* medium, as water, is refracted into a ray C E, which is nearer to the perpendicular C G than the incident ray B C; and, on the contrary, the ray E C passing out of a denser medium into a rarer, is refracted into C B, which is farther from the perpendicular.

The same thing may be otherwise illustrated, as follows:—Suppose a hole be made in one of the sides of the vessel, as at A, and a lighted candle placed within two or three feet of it, when empty, so that its flame may be at L; a ray of light proceeding from it will pass through the hole A in a straight line, L B C K, until it reach the bottom of the vessel at K, where it will form a small circle of light. Having put a mark at the point K, pour water into the vessel until it rise to the height A D; and the spot of light which was formerly at K will appear at E; that is, the ray which went straight forward when the vessel was empty to K, has been bent at the point C, where it strikes the water, into the line C E. In this experiment it will be necessary that the front of the vessel be of glass, in order that the course of the ray may be seen; and if a little soap be mixed with the water, so as to give it a little mistiness, the ray C E will be distinctly perceived. If, instead of fresh water, we fill the vessel with salt water, it will be found that the ray B C is more bent at C.

In like manner alcohol will refract the ray B C more than salt water, and oil more than alcohol; and a piece of solid glass, of the shape of the water, will refract the ray still more than the oil. Further explanation: In this figure B C is the incident ray, F G the perpendicular, B F the sine of the angle of incidence B C F, and G E the sine of the angle of refraction G C E. Now, it is a proposition that the sine B F, of the angle of incidence B C F, is either accurately, or very nearly, in a given proportion to the sine G E of the angle of refraction G C E. This ratio of the sines is as 4 to 3 when the refraction is made out of air into water; that is, B F : G E :: 4 : 3. When the refraction is made out of air into glass, the proportion is about as 31 to 20, or nearly as 3 to 2. If the refraction be out of air into diamond, it is as 5 to 2; that is, B F : G E :: 5 : 2. The denser the medium is the less is the angle and sine of refraction. If a ray of light, F G, were to pass from air into water, or empty space into air, in the direction C F, perpendicular to the plane A D, which separates the two mediums, it would suffer no refraction, because one of the essentials to that effect is wanting; namely, the obliquity of the incidence.

The refraction of the atmosphere produces an effect upon the heavenly bodies that their apparent positions are generally different from their real. In consequence of this the sun is seen before he comes to the horizon in the morning, and after he has sunk beneath it in the evening, and hence this luminary is never seen in the place in which it really is, except in places within the torrid zone, when it passes the zenith at noon. The sun is visible when thirty-two minutes of a degree below the horizon, and when the opaque curvature of the earth is interposed between our eye and that orb.

Fig. 89



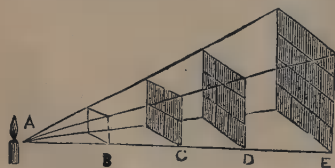
are for it to be refracted and reflected from. But if a luminous object be completely separated from you by the intervention of an opaque body, as is the sun from us during our night by the intervention of the body of the earth, then you have no light from the luminous object. Light passes through all transparent substances, such as the atmosphere, water, and glass; and in its passage through these substances of different densities it is refracted, as we have explained, according to certain laws. A body, ordinarily speaking, is said to be transparent when every part between its two surfaces is of the same density, and therefore the ray of light emerges, on the opposite side. In the case of the looking-glass, the ray of light would pass through it, being refracted, but for the coating of quicksilver which it has on its back, which prevents it passing through, and causes it to be reflected. A body is said to be opaque when the parts between its two opposite surfaces are of different densities, and so the rays of light are destroyed by the many refractions and reflexions, and do not emerge on the opposite side. All substances that are not transparent are opaque, though there are different degrees both of transparency and opacity. Light and heat usually accompany each other, but light is not always manifested where strong heat is evolved. The heat accompanying the solar light is so great that when concentrated on double-convex lenses it will be sufficient to fuse the densest metals. Mr. Parker, of Fleet Street, London, once made a burning glass three feet in diameter, and when fixed in its frame it exposed a clear surface of more than two feet eight inches in diameter, and its focus, by means of another lens, was reduced to a diameter of half an inch. The heat produced by this lens was so great, that iron plates were melted in a few seconds; tiles and slate became red-hot in a moment, and were vitrified, or changed into glass. Sulphur, pitch, and other resinous bodies were melted under water; wood-ashes, and those of other vegetable substances, were turned in a moment into transparent glass: even gold was rendered fluid in a few seconds; and notwithstanding the intense heat at the focus, the finger might without the slightest injury be placed in the cone of rays within an inch of the focus. The force of the heat collected in the focus of the double-convex glass is to the common heat of the sun as the area of the glass is to that of the focus; it may, of course, be a hundred or even a thousand times greater in the one case than in the other. When a fire or a candle burns, or a horse strikes his shoe against a stone, light as well as heat is evolved; but a stack of hay, or a pile of dry goods, if allowed to stand long enough in a damp condition, may be heated to a high pitch without any light being evolved. Light is produced in many ways artificially, as by chemical action in

the combustion of solids, liquids, and gases; by percussion, as in the use of the flint and steel, which is called "striking fire," and by the electric light, which may be considered the most intense and brilliant of all artificial lights. This last is procured from the ignition of two points of charcoal through which the current of electricity from a powerful battery is passed. But all terrestrial modes of obtaining light, such as chemical action, friction, ignition of solids, phosphorescence, crystallization, and the electric light, sink into insignificance before the great natural source of light, the sun, the centre of our planetary system, and the source both of light and heat to our world. Sir John Herschell has estimated that "the sun gives out as much light as 146 lime lights would do if each ball of lime were as large as the sun, and gave out light from all parts of its surface; and that the heat evolved from every square yard of the sun's surface is as great as that which would be produced by the burning of six tons of coal on it each hour."

Although it is said that light is emitted in straight lines from a luminous body it must not be understood that a given quantity of light goes on continuously in the same bulk or volume; it is continually expanding as it recedes from the point of emission. The areas of space filled with it as it proceeds are to each other as the squares of their respective distances from the luminous point of emission; and consequently the intensity or illuminating power of the light is inversely as the areas. Thus luminous bodies give, at the respective distances of two, three, or four yards, a fourth, a ninth, and a sixteenth, respectively, of the light they give at one yard from them; the areas illuminated and filled with the diffusing light being, at these several distances, four, nine, and sixteen times as great as at one yard distance. It may, therefore, be said more correctly that light diffuses itself universally in expanding volumes, bounded as the volumes increase by straight diverging surfaces, which form the boundaries of areas whose relative magnitudes are as the square of their distances.* The larger the luminous body is, the more space it will enlighten; and it is plain that the enlightened space will cor-

* This may be illustrated by the following figure: Suppose that light which flows from a candle A, and passes through a square hole B, is received upon a plane C, parallel to the plane of the hole; or let the figure C be considered as the shadow of the plane B. When the distance of C is double of B the length and breadth of the shadow C will be each double of the length and breadth of the plane B, and treble when A D is treble of A B, and so on. Therefore the surface of the shadow C

at the distance A C, double of A B, is divisible into four squares, and at a treble distance into nine squares severally equal to the square B. The light then which falls upon the plane B,



respond in form with the body which enlightens it. Thus, the sun being of globular figure,—and, as we may here, for illustration, suppose it luminous all over its surface,—enlightens an area, however great in extent, of spherical shape; the space nearest the sun being most enlightened, and the light becoming less as the distance from it becomes greater. The larger the luminous body is, too, at the greater distance will it be seen by the eye; also, the larger it appears at a given place the more light it will diffuse at that place; for the larger will its image be to be reflected and refracted from all objects; and, conversely, the smaller a luminous body appears from a given place the less light will it diffuse at that place, for the smaller will its image be reflected from all objects. When, therefore, a luminous body, of however great a size, is at so great a distance from a place as not to be perceivable by the eye, then it gives no direct light at that place, from the fact that there is no image of it to be reflected. Also, if one was situated beyond the range of our atmosphere, away out in the ethereal regions, it is determined he would experience no such flood of light as he does at the earth's surface, because of the absence of a reflecting medium. The denser and rougher in surface bodies are the better in general they reflect the light, for the image of the sun is reflected from one corner, face, or angle of rough surfaces to the other so as to make them more luminous than if they were smooth, though of the same density as they are. But the ether which exists beyond the limits of our atmosphere being so exceedingly rare, does not reflect the image of the sun; and the sun to an observer situated there, would appear like a luminous globe placed in a black canopy, and surrounded on all sides with pitchy darkness. So the stars might appear like luminous points scarcely distinguishable, in regions of the blackest darkness. The appearance of the earth would depend upon the distance of the observer from it; the nearer he would be to the earth the more luminous would it appear, the light being reflected from its surface and atmosphere.

On the subject of light, two leading theories have been propounded in the philosophic world. Sir Isaac Newton supposed that light was corpuscular, or composed of minute particles of a material nature,

being suffered to pass to double that distance, will be uniformly spread over four times the space, and consequently will be four times less intense in every part of that space. And at the treble distance it will be nine times thinner, and at a quadruple distance sixteen times thinner than it was at first. The quantities, therefore, of this rarified light received upon a surface of any given size and shape, when removed successively to their several distances, will be but one-fourth, one-ninth, one-sixteenth of the whole quantity received by it at the first distance A B. This law holds good with respect to the quantity of light received by the planets at their respective distances from the sun.

which are constantly emitted in all directions by luminous bodies. This hypothesis was adopted to a great extent, especially by British philosophers, but in later times it has given way to the theory of Huygens, who assumes that all space is pervaded by an elastic ether, the undulatory motions of which, when it is disturbed, manifest themselves in light, just as motion in water gives waves, or sound in air gives vibrations. Neither of these theories, it was afterwards thought, having fully explained the phenomena of light, another explanation was propounded, which corresponds very much with that of Huygens. This is that all space is filled with electricity, the elastic ether of Huygens, which, as is known, penetrates all bodies; and that the great ocean of electricity in free space, having nothing to compress it, yields freely in all directions, and only undulates when passing through other media, such as the atmosphere, where it suffers interruption, and also, to a certain extent, absorption. Thus far as to the theories. But the fact is that men will be ever changing their theories, rejecting old ones and substituting new ones, until they have come to a knowledge of the subject concerning which the theory is. No false theory will fully satisfy the mind, or last permanently. The phenomenon of light does not depend upon the emission of luminous particles from luminous bodies, nor does it necessarily depend upon all space being filled with a substance of any particular *name* such as ether, electricity, or any other name, provided it be a transparent and reflecting medium fitted to transmit the rays of light, as it is; but it consists simply in this, the infinite multiplication of the image of the luminous object by reflection and refraction from the media on all sides of it and to all visible distances from it. It depends simply upon this, that a luminous body exists, and is within visible distance, and then the amount of light places possess will depend upon the adaptedness or unfitness for reflexion of the media of these places.* As to the luminous body itself the phenomenon of light arises as does heat from the violent agitation of its ultimate elements in their seeking equilibrium by chemical separation or combination; and the production of the light is confined to the *luminous* body and is not necessarily common to any *illuminated* body with it. When a body is permanently luminous, as the sun is, then the space which it illuminates is always illuminated (unless parts of it, which, during certain intervals, are separated from the luminous body by the intervention of opaque bodies), and so the light

* The case of the Fixed Stars, whose light we see, but whose discs are beyond the reach of our best telescope, does not permit a contradiction to this explanation. It is their image infinitely multiplied by reflexion and refraction which we see, and they are visible in this way. But there are infinite numbers of stars so remote that their light never reaches us.

may be said to occupy time in passing from one point of the space to another, or from the luminous to the illuminated objects, in proportion to the distances, the theory giving it the rate of 196,000 miles a second. This theory is based upon deductions which have been drawn from observations made upon the satellites of Jupiter, at the time of their emergence from an eclipse. From these observations it was determined that it took the light a certain length of time to reach the earth from the satellites after their emergence from behind the body of the planet. Though it might appear that no perceptible time could intervene between the instant of their emergence from behind the body of the planet, coming into the flood of solar light, and their being seen by an observer on the earth, it does not thus follow; but as light occupies time in passing through space, it is in the perpetuation of the images. The reason why we do not always experience the light of the sun is because we are prevented from doing so by the intervention of the body of the earth between us and the sun during night-time, or by the intervention of some other object between us and the sun. But when the morning has come, and the side of the earth on which we live has come round to face the sun; or when any other body, which has shut out from us the light of the sun, has been removed, and that luminary shines with a clear face, we can see him just in the time it takes his luminous image to be perpetuated to us. Thus, the sun being nearly ninety-four millions of miles distant from us, about eight minutes must intervene from his actual coming to our horizon before we see him. In the same way the light of the stars visible to us is simply their luminous images propagated in all directions from them. Although the light of the stars is always present to the earth, and we only need to be on the side of the earth facing certain stars in order to see them instantly on a clear night, yet, according to the theory of the rate of motion of light, which, from observation, experiment, and analogy, and consideration of the results which might be expected in the case, from the conditions of time and space, seems quite reasonable, their light to reach us must have required time in proportion to their distances from us. A lighted candle, it is said, can illuminate a space of 4 cubical miles; that is, a spherical space whose diameter is $1\frac{3}{4}$ miles, the candle being placed in the centre. This candle, therefore, would be seen by an observer placed at any point in that space, say any extremity of a radius; and neither would it take the light any time to reach his eye, nor would there necessarily be any luminous particles emitted by the candle towards his eye. But the image of the candle is present in every point in the

space, and is reflected from all the reflecting media. The nearer the observer is to the candle the larger it appears, and the more intense is its light; the farther he removes from it the smaller it appears, and the less intense the light becomes, until finally the candle vanishes entirely from his sight, and there is no perceptible light from it in the surrounding space. So it is evident that when, on their emergence from behind the body of the planet, a sufficiently large portion of the surface of Jupiter's satellites has become enlightened to render them visible to a telescopic observer at the earth (for these satellites are not discernible by the naked eye), the time that has intervened between their emergence and his seeing them is the time it has taken their image to reach his eye.*

Electricity is not found to occupy any perceptible time in passing, by means of wires, to any point on the earth's surface, for the instant the message is sent by the telegraphic operator, that instant it is received at the other end of the wire, the distance being a little over twelve thousand miles, or half the earth's circumference. The farthest point on the earth's surface, reckoning from any given place, is somewhat over twelve thousand miles, which, at the rate of motion of light, would require less than one-fourth of a second.

The reader will be likely to observe himself, the absurdity of the theory which supposed light to be dependent upon the emission of luminous particles from a luminous body; for, for example, not a particle of the matter of which the sun is composed can ever go beyond the range of his immediate attraction; that is, every particle of the matter of which that body consists always did and always will belong to him; he cannot lose it. Secondly, he will see the absurdity of supposing that luminous particles of matter could penetrate through thick plates of glass or other transparent substances, which admit the light so freely, as windows, double or multiple; or the glass globes which surround our common lamps; or diamond, one of the hardest known substances. But, as we have said before, light is only a phenomenon, the image of the luminous object infinitely multiplied as well as the object itself, as far as the manifestation of light is concerned; while, on the other hand, the substance of which light is a manifestation may be called electricity, or any other name one pleases. It is everywhere present, and manifests the light when the conditions necessary for that manifestation exist. All bodies possess

* When immense distances are considered, it indeed appears reasonable that the passage of light requires time proportionate to the distance.† But those who consider the celestial suns as permanently luminous, rarely think what results might follow in the case from the requirements of space and time.

† See "Light and Electricity," by Tyndal.

in themselves, to a greater or less extent, the principle of light and of heat. But it mostly exists in a latent state in terrestrial bodies, needing to be called into action in order that it become apparent. These principles exist in an active state in the sun; and, therefore that luminary is the great source not only of light but of heat to the earth.* That part of the earth situated most favorably towards him receives the greatest quantity of his light and heat. The space which is constantly filled with the solar light is as constantly filled with the solar heat, and the reason we do not experience as much light and heat at one season of the year as we do at another is because the situation of the earth in relation to the sun does not admit of it. The earth is more than three millions of miles nearer the sun in December than in June, yet we have less light and heat in the former season than in the latter, owing to the parts of the earth which we occupy being turned away from the sun, or in other words, being situated more obliquely towards him. The earth is a dense body situated in the mighty ocean of the solar light, as a theatre upon which he may display his exhaustless power and energy, and give animation, beauty and sublimity, to every surrounding scene.

The Prism.

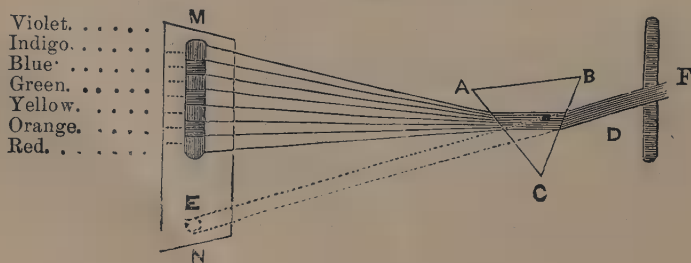
The prism is the most important and instructive of all optical lenses and it has enabled philosophers to add what may be called another branch of science, "Spectrum Analysis," to those already known. This instrument is triangular, and generally about three or four inches long. It is commonly made of white glass, as free as possible from veins, and bubbles, and other similar defects and solid throughout. Its lateral faces and sides are perfectly plane and finely polished. The angle formed by the two faces, one receiving the ray of light that is refracted in the instrument, and the other giving it an issue on its return into the air, is called the refracting angle of the prism. By means of this triangular piece of glass we are enabled to decompose and analyze a ray of light, and, from the knowledge so obtained, to account for the phenomena of colors. If a ray of light, proceeding directly from the sun, be admitted through a circular hole, half an inch in diameter, into a room, the walls of which should be as dark as possible, or hung with black calico, and a prism intersect it near the window, the ray will cease to go forward in a straight line, being refracted, or bent a little upwards out of its original di-

* Modern research has placed it beyond a doubt that heat is a mode of motion of the ultimate element of bodies. Thus, the great heat of the sun arises from the continued violent agitation of the elements of that immense body propagated to the earth and through space by means of the agitated ether.

rection, and will be decomposed, and exhibit, on a white screen placed opposite to the window to receive it, a beautiful spectrum, consisting of seven colors, beginning below and extending upwards in order of red, orange, yellow, green, blue, indigo, and violet. If the refracting angle of the prism ACB , in the figure,* be sixty four degrees, and the distance of the white screen from the prism eighteen feet, the length of the image will be about ten inches, and the breadth two inches. This oblong image is called the *prismatic spectrum*, and in it the red color is least, and the violet the most bent from the original direction of the solar beam. The sides of the spectrum are right lines distinctly bounded; and the ends are *semi-circular*. This circumstance shows that it is still the image of the sun, but elongated by the refractive power of the prism. By an ordinary glass prism, such as those used for glass lustres, the margins of the colors are not clearly defined, but seem to melt or mix, the one into the other. If a hollow glass prism filled with bisulphide of carbon be used, the seven colors of the spectrum are much more clearly defined. Sir Isaac Newton made this interesting and important discovery, that white light is a compound of rays of various kinds, having different colors, and indices of refraction; and that all the substances which appear colored when illuminated with white light, derive their colors only from a kind of "natural selection," that is, they may reflect certain colored rays and absorb or transmit others. He however, concluded, from various experiments on this subject, *that every substance in nature, provided it be reduced to the requisite degree of thinness, is transparent*. This is plain also, from the fact that all substances are of a nature reducible to an invisible gas. Many transpar-

* The separation of a ray of white light into different colors, by refraction, may be more accurately understood as represented in figure 91, where a ray of light is admitted through an aperture F in a window-shutter into a darkened chamber, and causing it to fall on the prism ABC . A ray, D , thus entering, and suffered to pass unobstructed, would form on a plane surface a circular disc of white light E ; but the prism being so placed that the ray may enter and quit it at equal angles, it will be refracted in such a manner as to form on a screen MN , properly placed, an oblong image, called the solar spectrum, and divided horizontally into seven colored spaces or bands of unequal extent. The angle ACB is the refracting angle of the prism. It is seen that the ends of the spectrum are semicircular.

Fig. 91



ent media reflect one color and transmit another; gold leaf reflects the yellow, but it transmits a sort of green color by holding it up against a strong light.

Light is said to be the source of all colors; but, if the principle of light is inherent in all substances, how can it be said that colors are not inherent in them? Light itself is in every case, a manifestation of matter. The matter which gives rise to the light is sometimes as in the case of carburetted hydrogen gas, itself invisible; yet when properly examined, the light proceeding from it displays all colors, and renders them apparent in all other objects. The colors displayed by different objects, owing to their peculiar adaptedness for absorbing or reflecting certain of the colors of light, are various, and of different degrees of intensity; but the colors displayed by light in the prism are permanently the same, only, it may be, differing slightly in their intensity, according to the source whence the light is derived.

When the solar spectrum, obtained as already described, is thrown upon a white screen, it is amusing to see the effect of different colored rays upon different pigments; and if slips of colored paper be used the results are very distinct. By passing the ray of white light through two prisms, inverted to each other, and filled with bisulphide of carbon, the spectrum may be made to stretch much farther across the screen, and the sunbeam undergoes by the double refraction a greater amount of dispersion. The colors are now more clearly separated, and the experiments with the slips of colored paper or other pigments, can be made with much greater facility. The drawing apart or separation of the colors is called dispersion, and thus the structure may be made shorter or longer, by using prisms of different dispersive powers. Although it is difficult for the best eyes to point out the exact boundaries of each color, Sir Isaac Newton concluded after repeated experiments, that the lengths of the colors with the particular glass prism which he used were as follows: Red 45, orange 27, yellow 40, green 60, blue 60, indigo 48, violet 80; total number of equal spaces into which the spectrum was divided, 360°. By making a hole in the screen opposite any one of the colors of the spectrum, and placing the screen in such a position as to allow that color only to pass, and by letting the color thus separated fall upon a second prism, he found that each of the colors was alike refrangible, because the second prism could not separate them into an oblong image, or into any other color. Hence he called all the seven colors *simple* or homogeneous, in contradistinction to white light, which he called compound or heterogeneous. For he also ascertained that the colors could be brought together, again recombined; and that the

result was the recomposition of white light. This synthesis of color is readily shown by using a second prism placed in an inverted position to the other, and allowing the ray of light to pass through this, or by allowing the colored rays to fall upon a double-convex lens, when they are brought to a focus, and a spot of white light alone is visible. The experiment can be varied by mixing seven different colored powders together, the colors being, of course, as near as possible to those of the solar spectrum; or these colors may be painted on a circular piece of cardboard, and when this is properly adjusted, and whirled round with sufficient velocity, the colors seem all blended together, and produce the nearest imitation of white light.

If a sunbeam is passed through a double-convex lens, which represents a series of prisms with their bases attached to each other, and their thinnest edges outward, it is not to be wondered at that the disc of light obtained should be *fringed with colors*, because it has been shown that a prism decomposes white light. If all the colors were of the same refrangibility there would be no fringes of colors on the edges of bodies seen through a common telescope or microscope; but as the focus of the red ray is formed further away from the lens than that of the blue ray, because the latter is more refractive than the former, it follows that a separation of color must occur, which is technically termed *chromatic aberration*. Newton, however, examined the ratio between the sines of incidence and refraction of the decomposed rays, and found that each of the seven primary color-making rays had certain limits within which they were confined. Thus, let the sine of incidence in glass be divided into 50 equal parts, the sine of refraction into air of the *least* refrangible, and the *most* refrangible rays will contain respectively 77 and 78 such parts. The sines of refraction of all the degrees of red will have the intermediate degrees of magnitude from 77 to $77\frac{1}{3}$; orange from $77\frac{1}{3}$ to $77\frac{1}{2}$; yellow from $77\frac{1}{2}$ to $77\frac{2}{3}$; green from $77\frac{2}{3}$ to $77\frac{1}{2}$; blue from $77\frac{1}{2}$ to $77\frac{2}{3}$; indigo from $77\frac{2}{3}$ to $77\frac{1}{3}$; and violet from $77\frac{1}{3}$ to 78. From the foregoing statements it is evident, as has been shown above in the case of double-convex lenses, that as any portion of an optic glass bears a resemblance to the form of a prism, the component rays which pass through it must necessarily be separated, and will consequently paint or tinge the object with colors. The edges of every convex lens approximate to this form, and it is on this account that the edges of objects viewed through them are found to be tinged with the prismatic colors. In such a glass, therefore, the different colored rays will have different foci, and will form their respective images at different distances from the lens.

The amount of dispersion of the colored rays in convex lenses depends upon the focal length of the glass, the spaces which the colored images occupy being about the twenty-eighth part. Thus, if the lens be twenty-eight inches focal distance, the space between the red and the violet colors of the spectrum will be about one inch; if it be twenty-eight feet focal distance the same space will be one foot, and so on in proportion. When such a succession of images, formed by the different colored rays is viewed through an eye-glass, it will appear to form but one image, and consequently very indistinct, and fringed with various colors; and as the red color is largest or seen under the greatest angle, the extreme parts of the confused image will be red, and a succession of the prismatic colors will be formed within this red fringe, as is generally formed in common refracting telescopes, constructed with a single object-glass. To this circumstance it is owing that the common refracting telescope cannot be much improved without having recourse to lenses of very long focal distance; and hence about 180 years ago such telescopes were constructed of 80, 100, and 120 feet focal length. But still the image was not formed so distinctly as desired, and the aperture of the object-glass had to be limited. This is a defect which was long regarded as without a remedy, and even Newton himself despaired of discovering any means by which the defects of refracting telescopes might be remedied, and their improvement effected. But this difficulty has been most ingeniously surmounted by combining lenses of unequal dispersive material; and it was Mr. Dollond who proved in 1757 that by combining a concavo-convex lens of flint glass with a double-convex one of crown glass a lens was obtained which virtually refracts the various colored rays to one focus, and is, therefore, achromatic, that is, free from color. For absolute achromatism various lenses are necessary, but for all practical purposes two are found to be sufficient, provided their curvatures are such as to combine the yellow and red rays.

It was originally observed by Newton, and the fact has since been confirmed by the experiments of Herschell, that the different colored rays have not all the same illuminating power. The violet rays appear to have the least illuminating effect; the indigo more; and the effect increases in the order of the colors, the green being very great; between the green and yellow the greatest of all; the yellow the same as the green; but the red less than the yellow. Herschell also endeavored to determine whether the power of the differently colored rays to heat bodies varied with their power to illuminate them. He introduced into a dark room a beam of light which was decomposed by a prism, and then exposed a very sensible

thermometer to all the rays in succession, and observed the heights to which it rose in a given time. He thus found that their power to heat increased from the violet to the red. The mercury in the thermometer rose higher when its bulb was placed in the indigo, than when it was placed in the violet; still higher in blue, and highest of all at red. Upon placing the bulb of the thermometer below the red, quite out of the spectrum, he was surprised to find that the mercury rose highest of all, and concluded that rays proceed from the sun, which have the power of heating, but not of illuminating bodies. These rays have been called invisible solar rays; they were about half an inch from the beginning of the red rays; at a greater distance from this point the heat began to diminish, but was quite perceptible at a distance of one and a half inches. He determined that the heating power of the red to that of the green rays was as $2\frac{3}{4}$ to 1, and of red to violet as $3\frac{1}{2}$ to 1. He afterwards made experiments to collect these invisible caloric rays, and caused them to act independently of the light, from which he concluded, that they are sufficient to account for all the effects produced by the solar rays in exciting heat; that they are capable of passing through glass, and of being refracted and reflected, after they have been finally detached from the solar beam.

M. Ritter of Jena, Dr. Wollaston, Beckman and others have discovered that the rays of the spectrum are possessed of certain chemical properties; that beyond the least brilliant extremity of the spectrum, namely, a little beyond the violet ray, there are invisible rays which act chemically, while they have neither the power of heating nor of illuminating bodies. Muriate of silver exposed to the action of the red rays becomes blackish; a greater effect is produced by the yellow; a still greater by the violet; and the greatest of all by the invisible rays beyond the violet. When phosphorus is exposed to the action of the invisible rays beyond the red, it emits white fumes, but the invisible rays beyond the violet extinguish them.

It has likewise been found that certain rays of the spectrum, particularly the violet, possess the property of communicating the magnetic influence. Morchini, of Rome, appears to have been the first who discovered that the violet rays of the spectrum had this property. The result of his experiments was, however, involved in doubt, but it was believed to be established by a series of experiments, carried out by Mrs. Somerville, a lady who is celebrated for her scientific pursuits. This lady having covered half a sewing needle, of about an inch long, with paper, exposed the other half for two hours to the violet rays. The needle had then acquired north polarity.* The indigo rays produced nearly the same effect; and the

* When a magnet is brought near a bar of iron or piece of wire or the like it effects in the opposite ends of the latter opposite or contrasted properties or qualities, i.e., the opposite poles of the bar become positively and negatively electrified respectively. This arises from magnetism, an intense electric force, acting at right angles to the ordinary electric direction. The

blue and green rays produced it in a still less degree. In the yellow, orange, red, and invisible rays, no magnetic influence was exhibited, although the experiment was continued for three successive days. The same effects were produced by enclosing the needle in blue or green glass, or wrapping it in blue or green ribbon, one half of the needle being always covered with paper.

Though the whole space of the solar system is constantly replenished with light and heat, yet the whole system is constantly dependant on the sun for them; and as a candle when extinguished leaves darkness instantly behind it, so the sun, if by any means it were extinguished, would leave our whole system instantly in pitchy darkness. This we positively know from the fact that no image can appear in a mirror unless an original be present to the mirror; and that the sun exists in a luminous state we know from the fact that, when all things are prepared for it, his luminous image is instantly impressed upon the spectrum. That it is the sun's elongated image is evident from the ends of the spectrum being arcs of a circle; the elongation being effected by the different refractive powers of the different colored rays. Now it seems quite evident that the different powers of dispersion, of illuminating, of heating, of producing chemical or magnetic effects, possessed by the different colored rays, and by the invisible rays beyond these, may arise, as the different degrees of light and heat themselves, from the nature of the different combustible substances of which the sun is made up. That these substances are not in general very different from the substances which produce light in the earth, we reasonably infer from the consideration that any common artificial light, such as a candle, a gas, or a petroleum light, gives the same spectral colors as the solar light does; only the colors may vary slightly in intensity. The *spectral bands*, however, which we shall next consider, may give us some insight into the nature of the component substances of the sun's ignited parts.

There was one feature of the solar spectrum which escaped the observation of Newton, and it tends to show how much knowledge may be lost by performing an experiment in the least perfect manner. He allowed his sunbeam to pass through a circular hole to the prism, and thus missed the dark bands and fixed lines which cross the colors from end to end of the spectrum at right angles to its length. Dr. Wollaston made an important discovery by admitting the light through a narrow slit, instead of a circular aperture, which is thus described by Sir David Brewster. In the year 1802, Dr. Wollaston announced that in the spectrum formed by a fine prism of flint glass, free from veins, when the luminous object was a slit the twentieth part of an

polarization of Light through prisms is exhibited variously, the opposite sides of the refracted ray or spectrum being its poles. This idea of polarity or opposites, which is an affection of matter (see note to p. 26), is all-pervading in nature, extending as high as to the highest and as low as to the lowest and may be fairly represented and exemplified, as to its effects in the sexes within the species.

inch wide, and viewed at the distance of ten or twelve feet, there were two fixed dark lines, one in the green and the other in the blue spaces. This discovery did not excite any attention, and was not followed out by its ingenious author. Without knowing of Wollaston's observations, Mr. Fraunhofer, of Munich, by viewing through a telescope the spectrum formed from a narrow line of solar light with the finest prism of flint glass, discovered that the surface of the spectrum was crossed throughout its whole length by dark lines of different breadths. None of these lines coincide with the boundaries of the colored spaces. They are nearly 600 in number. The largest of them subtends an angle of from five seconds to ten seconds. From their distinctness, and the facility with which they may be found, five of these lines have been particularly distinguished by Fraunhofer. One of the important practical results of this discovery is that those lines are fixed points in the spectrum, or rather that they have always the same position in the colored spaces in which they are found. Fraunhofer likewise discovered in the spectrum produced by the light of Venus, the same streaks as in the solar spectrum; in the spectrum of the light of the star Sirius he perceived three large streaks, which according to appearance, had no resemblance to those of the solar spectrum; one of these was in the green, two in the blue. The stars appear to differ from one another in their streaks. The electric light also is found to differ somewhat from the light of the sun, and that of a candle, in regard to the spectral streaks. When the spectrum is formed by the sun's rays, either direct or indirect, as from the sky, clouds, rainbow, moon, or planets, the black bands are always found to be in the same parts of the spectrum, and under all circumstances to maintain the same relative position, breadth and intensities.

A very convenient instrument has been invented by Mr. John Browning called the "Miniature Spectroscope," by which, at any time, the solar spectrum may be observed in all its beauty of color; and the dark lines are easily seen by properly adjusting the width of the slit. When this is widely opened, the spectrum is more brilliant, because more light is admitted to the series of prisms contained in the instrument, but the lines are not then visible. By reducing the size of the aperture, it presents the appearance of striped ribbon, and is found to be crossed in the direction of its breadth by a number of dark lines. This instrument in the case measures four inches in length, and rather more than three-fourths of an inch in diameter; it is therefore easily portable in the pocket, and is thus kept ready for any special use, such for instance as observing the bright bands of color emitted by certain flames, or intensely hot gaseous matter, similar to that coming from the furnace in which the Bessemer pro-

cess is carried on; and it is by the employment of the spectroscope that the exact moment of the completion of the process for making steel or pure iron may be determined by a person skilled in the use of this instrument.

In order to properly distinguish the spectral lines, it is necessary to classify the spectra obtained from the different sources of light. Thus, the light obtained from the incandescence of two graphite electrodes by the voltaic battery, and called the "electric light," will, provided the graphite be middling pure, exhibit a continuous band of colors, perfectly free from all black lines. Such a spectrum teaches us nothing more than that light can be decomposed into seven colors. An observer looking at such a spectrum could not tell the exact source of the light, or say whether it was evolved by incandescent charcoal, lime, or platinum. Such a pure band of colors is called a *spectrum of the first order*. If a spirit lamp, burning pure and good spirit, is used as the source of heat, and a platinum wire, looped at the end, and dipped into a solution of common salt, is now held in the spirit flame, it changes yellow; and if the little hand spectroscope is directed towards it a yellow line is distinctly seen, whose position is toward the red end of the spectrum. When a more intense heat is used, such as the electric arc, the sodium line is double, and is then exactly coincident with the dark, double solar line known as Fraunhofer's (D) line. If nitrate or chloride of strontium be used, and placed, like the chloride of sodium, upon the looped platinum wire in the flame, and observed with the spectroscope, the colored bands are more numerous. There are eight remarkable lines, one blue band, one orange, and six red. All the metals and the salts which can be converted into *luminous* gas give bright lines instead of dark ones; and the various spectra obtained in this way are called *spectra of the second order*.

The fact that metals and their salts will always give the same colored bands invariably in some particular part of the spectrum, affords a most delicate measure of quantitative analysis, which is generally employed where the presence of a minute quantity of some metallic salt is suspected. By means of spectral analysis, the three-millionth part of a millogramme of soda can be easily detected, of lithium the nine-millionth part, of calcium the ten-thousandth part of a millogramme. The spark from the great induction coil, when passed through the air, is always of a light yellow color, and when examined by the spectroscope it gives the yellow line of sodium; and this is said to be supplied from the dust always floating in the air, which is continually supplied with particles of salt from the spray carried by the winds from the ocean.

There is but one more order to speak of; this is, *spectra of the third order*, of which the best type is the solar spectrum, crossed by black lines. "The spectra of this order," says Mr. Huggins, "consist of the spectra of incandescent, solid, or liquid bodies, in which the continuity of the colored light is broken by dark lines. These dark spaces are not produced by the source of the light. They tell us of vapors through which the light has passed on its way, and which have robbed the light by absorption of certain definite colors, or rates of motion. Such spectra are formed by the light of the sun and stars." If the light producing the yellow lines in sodium by the electric arc be allowed to pass through the vapor of metallic sodium, the yellow lines change to black lines. The sodium vapor absorbs the same kind of light as it emits; and it was by this remarkable discovery that Kirchhoff identified many of the dark lines in the solar spectrum, with the bright lines obtainable from terrestrial substances; and ascertained that, in the solar atmosphere, there existed sodium, calcium, barium, magnesium, iron, chromium, nickel, copper, zinc, strontium, cadmium, cobalt, and hydrogen. If the evidence depended only on the coincidence of one or two dark solar lines with the bright bands from the vapors of the terrestrial metals, it would be worth little or nothing; but in a complicated series of sets of lines, such as would be produced by the above metals, *all the lines coincide*; and in speaking of one of those metals, Kirchhoff remarks: "The observations of the solar spectrum appear to me to prove the presence of iron-vapor in the solar atmosphere, with as great a degree of certainty as we can attain in any question of natural science." Messrs. Huggins and Miller have continued observations with the planets, the stars, the nebulae, and the comets, and have added largely to our knowledge of the constitution of these distant heavenly bodies.

The Rainbow.

At certain times, when there is a shower, either around us or at a distance from us, in an opposite direction to that of the sun, we see a kind of arch or bow in the sky, adorned with all the primary colors of light. This phenomenon, which is one of the most beautiful meteors in nature, is named the rainbow. The rainbow was for ages considered as an unexplainable mystery, and by some nations it is said to have been adored as a deity. Even after the light of modern science had begun to dispel the ignorance from the minds of men, it was a considerable time before any discovery of importance was made as to the true causes which co-operate in the production

of this phenomenon; and it was not until Newton discovered the different refrangibility of the rays of light, that a complete and satisfactory explanation could be given of all the circumstances connected with the rainbow. This beautiful meteor never makes its appearance to the spectator but when he is situated between the sun and the shower; and it is produced by the reflection and refraction of the rays of light from the falling drops of rain. It has been observed before that water is a transparent medium, and transmits the rays of light, refracting or bending them a little from the course they were pursuing before entering it; but while it transmits some rays of light, refracting them, it reflects others, both from its surface and inside its surface. There are usually two bows seen at the same time, one a little above the other, and encircling it; the inside one is called the *primary*, the outside the *secondary* bow. The secondary bow is usually much fainter in its colors than the primary. Now these bows are formed by the drops of rain in a given circle acting like prisms, and separating the rays of light, by refraction and reflection, into their prismatic colors; the red being lowest and the violet highest in the primary bow; and the violet lowest and red highest in the secondary. It has been shown from the experiments of scientific men, who possessed both the inclination and leisure for such pursuits, that the first or primary bow is produced by one reflection and two refractions of the ray of light in the drop of rain; and the secondary bow by two refractions and two reflections in the drop. In the first



case, the ray of light enters the drop from above, and on entering a new medium is, of course, refracted; it pursues its course in the drop, is reflected inside of it, and emerges from the same hemisphere of the drop as that in which it entered, and in emerging is refracted. Thus the ray is refracted in entering the drop, a new and denser medium; is reflected in the drop, the same medium; and is refracted again in emerging from the drop to the air, a different medium from the drop.

In the second case the ray strikes the drop rather on the lower, side, and is refracted on entering it; pursues its course to the other side of the drop on the inside, and is reflected from the lower part of the inside surface of the drop; is reflected again from the inside of the upper surface of the drop; and in emerging from the drop is refracted. Thus, as in the first case, the ray is refracted in entering the drop, a new medium; is reflected twice in the drop, the same medium; and in emerging to the air is again refracted. Hence in consequence of the two reflections in the drop in the last case the ray must in its course have described a four-sided figure, perhaps a square or a parallelogram. The same thing happens in the given circular space with respect to a whole shower as happens with respect to one or two drops; and by the constant falling of the rain the image is preserved constant and perfect. This subject may be partially illustrated in this way; take either a small solid glass globe or a small glass globe filled with water, and suspend it so high in the solar rays that the observer with his back to the sun can see the globe *red*; if it then be lowered slowly he will see it orange, then yellow, then green, then blue, then indigo, then violet; so that the drop of rain, as this, at different heights shall present to the eye of the observer the seven prismatic colors in succession. It must not be thought that any perceptible time is taken up in the refractions and reflections we speak of, as by which the rainbow is formed in the falling rain-drops, or in the lowering glass globe; the phenomenon is produced by the positions of the falling drops, or of the globe, in relation to our eye and to the sun. Fig. 93 illustrates the cause that produces the rainbow; the lower drop, or series of drops, representing the primary bow, the upper the secondary. The rainbow assumes a semi-circular appearance because it is only at certain angles that the refracted rays come to our eyes, as is evident from this experiment of the glass globe, which will reflect the different colored rays only in a certain position. The red rays make an angle of forty-two degrees two minutes; and the violet an angle of forty degrees and seventeen minutes. Thus if a line be drawn horizontally from the spectator's eye, it is plain that the angles formed with a

line of a certain dimension in every direction will produce a circle, as will appear by attaching a cord of a certain length to a given point, around which, as around an axis, it may turn; and in every point it will describe an angle with the horizontal line of a certain and determinate length. Now all the drops of water within the *difference* of these two angles, namely, one degree and forty-five minutes (supposing the ray to proceed from the centre of the sun), will exhibit severally the colors of the prism and constitute the interior bow of the cloud. This holds good at whatever height the sun may happen to be in a shower of rain. If he be at a high altitude the rainbow will be low; if at a low elevation, the rainbow must be high; and if a shower happen in a vale when the observer is on a mountain he will sometimes see the bow in the form of a *complete circle* below him. The largest angle, then, or circle, is formed by the red rays, the middle one the green, and the smallest the purple or violet. If the spectator alters his position, he will see a bow but not the same as before; and if there be many spectators they will see each a different bow, though it appears to be the same. If there were no ground to intercept the rain and the view of the spectator, the rainbow would form a complete circle whose centre is diametrically opposite to the sun. Such circles are often seen in the spray of the sea or of a cascade, or from the tops of lofty mountains when the shower happens in the vale below. Rainbows of various descriptions are frequently seen rising amid the spray and exhalations of waterfalls, and among the waves of the sea, whose tops are blown by the wind into small drops. There is one regularly seen when the sun is shining, and the observer in a proper position, at the Fall of Staubbach, in the bosom of the Alps; one near Schaffhausen; one at the cascade of Lauffen; one at the Cataract of Niagara, and one at the Chaudiere Falls, Ottawa.

A more beautiful one than any of these is said to be seen at Terni, where the whole current of the river Velino, rushing from a steep precipice of nearly two hundred feet high, presents to the observer below a variegated circle, overreaching the fall, and two other bows suddenly reflected on the right and left. Don Ulloa, in the account of his travels in South America, relates that circular rainbows are frequently seen on the mountains above Quito, in Peru. A naval friend, says Mr. Bucke, informed me that as he was one day watching the sun's effect upon the exhalations near Juan Fernandez, he saw upwards of five-and-twenty *ires marinæ* animate the sea at the same time. In these marine bows the concave sides were turned upward, the drops of water rising from below, and not falling from above, as in the instance of aerial arches. Rainbows are also occasion-

ally seen on the grass in the morning dew, and likewise when the hoar-frost is descending. Dr. Langwith once saw a bow lying on the ground, the colors of which were almost as lively as those of a common rainbow. It was not circular, but oblong, and was extended several hundred yards. The colors took up less space and were much more vivid in those parts of the bow which were near him, than in those which were at a distance. When M. Labillardière was on Mount Teneriffe, he saw the contour of his body traced on the clouds beneath him, in all the colors of the solar bow. He had previously witnessed this phenomenon on the Kesrouan, in Asia Minor. The rainbows of Greenland are said to be frequently of a pale white, fringed with a brownish yellow, arising from the rays of the sun being reflected from a frozen cloud.

A rainbow may be produced at any time by artificial means, when the sun is shining, and not at too great an altitude above the horizon. This is effected by means of artificial fountains, which are intended to throw up streams of water to a great height. These streams, when they spread very wide and blend together in their upper parts, form, when falling, an artificial shower of rain. If, then, when the fountain is playing, we move between it and the sun to a proper distance from the fountain, until our shadow points directly toward it, and look at the shower, we shall observe the colors of the rainbow strong and lively; and what is especially noticeable, the bow appears, notwithstanding the nearness of the shower, to be as large and as far off as the rainbow which we see in a natural shower of rain. The same experiment may be made with candle-light and with any instrument that will form an artificial shower.

The following is a summary of the principal facts which have been ascertained respecting the rainbow: 1. The ordinary rainbow can only be seen when it rains, and in that part of the heavens opposite to the sun. 2. Both the primary and secondary bows are variegated with all the prismatic colors, the red being the highest color in the primary, or brightest bow; and the violet the highest in the secondary or exterior bow. 3. The primary rainbow can never be a greater arc than a semicircle; and when the sun is set no bow in ordinary circumstances can be seen. 4. The breadth of the inner or primary bow, supposing the sun but a point, is one degree and forty-five minutes; and the breadth of the exterior bow three degrees and twelve minutes, which is nearly twice as great as that of the other; and the distance between the bows is eight degrees and fifty-five minutes. But since the body of the sun subtends an angle of about half a degree, by so much will each bow be increased, and their distance diminished; and, therefore, the breadth of the interior bow

will be two degrees, fifteen minutes; and that of the exterior three degrees, forty-two minutes; and their distance eight degrees, twenty-five minutes. The greatest semi-diameter of the interior bow, on the same grounds, will be forty-two degrees, seventeen minutes; and the least of the exterior bow fifty degrees, forty-three minutes. 5. When the sun is in the horizon, either in the morning or evening, the bows will appear complete semicircles. On the contrary, when the sun's altitude is equal to forty-two degrees, two minutes, or to fifty-four degrees, ten minutes, the summits of the bows will be depressed below the horizon. Hence, during the days of summer, within a certain interval each day, no visible rainbows can be formed, on account of the sun's high elevation above the horizon. 6. The altitude of the bows above the horizon, or surface of the earth, varies according to the elevation of the sun. The altitude at any time may be taken by a common quadrant, or any other angle-measuring instrument; but if the sun's altitude at any particular time be known, the height of the summit of any of the bows may be found by subtracting the sun's altitude from forty-two degrees, two minutes, for the inner bow; and from fifty-four degrees, ten minutes, for the outer. Thus, if the sun's altitude be twenty-six degrees, the height of the primary bow would be sixteen degrees, two minutes; and that of the secondary bow twenty-eight degrees, ten minutes. It follows that the height and the size of the bows diminish as the altitude of the sun increases. 7. If the sun's altitude be more than forty-two degrees, and less than fifty-four, the exterior bow may be seen, though the interior one is invisible. Sometimes only a portion of an arch will be visible, while all the other parts of the bow are invisible. This happens when the rain does not occur in a space of sufficient extent to complete the bow; and the appearances of the position, and even of the bow itself, will be various, according to the nature of the situation, and the space occupied by the rain.

Lunar rainbows are sometimes formed at night by the rays of the moon striking on a rain-cloud, especially when the moon is about at its full; but such phenomena are not often observed. Aristotle is said to have considered himself the first who saw a lunar rainbow. These bows appear distinct and well-defined, but the prismatic colors are usually not very distinct. They may be all distinguished by attending to the phases and position of the moon. If the moon be not visible above the horizon, if she be in her first or last quarter, or if an observed phenomenon is not in a direction opposite to the moon, we may conclude with certainty that whatever appearance is presented no lunar rainbow appears. The writers of the Bible frequently allude to the rainbow as one of the emblems of the majesty and glory

of the Deity. Ezekiel represents the throne of the Almighty as adorned with a brightness "like the appearance of a bow that is in the cloud in the day of rain; the appearance of the likeness of the glory of Jehovah." And in the visions recorded in the book of Revelation, where the Most High is represented as sitting on a throne, it is said: "there was a rainbow round about the throne, in sight like unto an emerald," an emblem of his glory, and holiness, as well as of his propitious character, as there represented. In the apocryphal book of Ecclesiasticus it is alluded to by the son of Sirach after this manner: "Look upon the rainbow, and praise him that made it; very beautiful it is in the brightness thereof. It compasseth the heavens about with a glorious circle, and the hands of the Most High have bended it."

ON COLORS; AND OTHER EFFECTS OF LIGHT.

The common theory supposes or represents that colors are inherent in light alone; whereas it is evident light only makes manifest what exists in something or everything else. The principles of light, of colors, and of heat co-exist in everything. Burn a stick of wood and you obtain a blaze, from which you can derive all the prismatic colors; you derive light, heat, electricity, and colors, from the same bit of fuel. Light is that manifestation of matter which opens up to us the universe, displays to us all other objects, and is an object itself for us to experiment upon. Thus we can experiment upon the properties of light, as well as upon all other things by means of light. It is essential to the existence of all vegetables and animals; and this is a proof that the solar light has always existed as now, and, therefore, that all colors have always been displayed. It is, however, strictly true, that without light there would be no colors; although they existed in principle everywhere and in everything. All colors, therefore, are dependent upon light. Of all the phenomena which vegetables exhibit, there are few that appear more extraordinary than the energy and constancy with which their stems incline towards the light. Most of the discous flowers follow the sun in his course. They attend him to his retreat in the evening, and meet his rising lustre in the morning, with the same unerring law. They unfold their petals on the approach of this luminary; they follow his course by turning on their stems, and close them as soon as he disappears. Also, if a plant be shut up in a dark room, and a small hole be afterwards opened, by which the light of the sun may enter, the plant will turn towards that hole, and even alter its shape, in order to incline towards it; so that though it was straight before, it will

in time become crooked, that it may get near the light. Vegetables placed in rooms where they receive light only from one direction always extend themselves in that direction. If they receive light from two directions, they incline rather towards that which is strongest. It seems to be rather the light than the heat of the sun which the plant thus covets; for though a fire be kept in the room capable of giving out a much stronger heat than the sun gives there, the plant will turn away from the fire, in order to enjoy the solar light. Trees growing in dense forests, where they receive most of their light from above, direct their shoots almost invariably upward, and, therefore, become much taller and less spreading than such as stand single; they are also more intensely green toward the tops. The green color of vegetables is found to depend upon the sun's light being allowed to shine on them; for without the influence of the solar light they are always of a whitish aspect. It is found by experiment that if a plant which has been reared in darkness, is exposed to the light of day, in two or three days it will acquire a green color perceptibly similar to that of plants grown in open daylight. If we expose to the light one part of the plant whether leaf or branch, this part alone will become green. If we cover any part of a leaf with an opaque substance, this part will remain white, while the rest becomes green. The whiteness of the inner leaves of cabbages is a partial effect of the same cause; and any one may produce many other examples of the same kind. M. Decandolle, who seems to have paid particular attention to this subject, makes the following remarks: "It is certain that between the white state of plants vegetating in darkness and complete greenness, every possible intermediate degree exists, determined by the intensity of the light. Of this, any one may easily satisfy himself by attending to the color of a plant exposed to the full daylight; it exhibits in succession all the degrees of verdure. I had already seen the same phenomenon in a particular manner by exposing plants reared in darkness to the light of lamps. In these experiments, I not only saw the color come on gradually, according to the continuance of the exposure to light, but I satisfied myself that a certain intensity of permanent light never gives to a plant more than a certain degree of color. The same fact readily shows itself in nature, when we examine the plants that grow under shelter or in forests, or when we examine in succession the state of the leaves that form the heads of cabbages. * "

It is likewise found that the perspiration of vegetables is increased or diminished in a certain measure by the degree of light which falls upon them. M. Guetard informs us that a plant exposed to the rays

* *Memoires de la Société d'Arensil.*

of the sun has its perspiration increased to a much greater degree than if it had been exposed to the same heat inside the shade. And, it is said, the experiments of Mr. P. Miller, and others, go to prove that plants uniformly perspire most in the forenoon, though the temperature of the air in which they are placed should be unvaried. Vegetables are likewise found to be indebted to light for their smell, taste, and combustibility, maturity, and the resinous principles which equally depend upon it. The aromatic substances, resins, and volatile oils, are the productions of Southern climates, where the light is more pure and intense. Another remarkable property of light on the vegetable kingdom is, that when vegetables are exposed to open daylight, or to the sun's rays, they emit oxygen gas, or vital air. It has been proved that in the production of this effect the sun does not act as a body that heats. The emission of the gas is determined by the light; the pure air is, therefore, separated by the action of light and the operation is stronger as the light is more intense. By this continual emission, the atmosphere is continually purified, and the loss of pure air occasioned by respiration, combustion, fermentation, putrefaction and numerous other processes which have a tendency to vitiate this fluid, so essential to the maintenance and vigor of animal life, is repaired; so that in this way, by the agency of light, a due equilibrium is always maintained between the constituent parts of the atmosphere.

It is evident that colors exist but in principle, ~~except~~ for the agency of light; and it is owing to the surfaces of bodies being disposed to reflect certain colors rather than others that we have such a variety of colors. When the disposition is such that a body reflects every kind of ray in the mixed state in which it receives them, that body appears white to us, which properly speaking, is no color, but rather the combination of all the colors. When a body absorbs nearly all the light which falls upon it that body appears *black*; it transmits to the eye so few reflected rays that it is scarce perceptible in itself, and its presence and form make no impression upon us unless as it interrupts the brightness of the surrounding space. Black is therefore the absence of all colors. If the body has a fitness to reflect one sort of rays more abundantly than others, by absorbing all the others, it will appear of the color belonging to that species of rays. Thus, the grass is green because it absorbs all the colors except green. It is the green rays only which the grass, the foliage of the trees and shrubs, and all the other verdant parts of the landscape reflect to our sight, and which make them appear green. In the same manner the different flowers reflect their respective colors; the rose the red rays; the jonquil the yellow; the marigold

the orange; and every object whether natural or artificial, appears of the color which its peculiar texture is adapted to reflect. A great number of bodies are fitted to reflect at once several kinds of rays, and consequently they appear under mixed colors. It often happens that of two bodies which are green, for example, one may reflect the green of light and the other the mixture of yellow and blue. This quality, which varies to infinity, occasions the different kinds of rays to unite in every possible manner and every possible proportion; and hence the inexhaustible variety of shades and hues which is seen diffused over the scene of creation.

Every object is black or colorless in perfect darkness, and it only appears colored as soon as light renders it visible. This will become more plain from the following experiment. If we place a colored body in one of the colors of the spectrum which is formed by the prism, it appears of the color of the rays in which it is placed. Take, for illustration, a red rose, and expose it first to the red rays, and it will appear of a more brilliant, ruddy hue; hold it in the blue rays and it appears no longer red, but of a dingy blue color; and in like manner its color will appear different when exposed to all the other differently colored rays. This is the reason why the colors of objects are altered by the nature of the light in which they are seen. The colors of ribbons, of cloths, of silks, or woollen stuffs, are not exactly the same when viewed by candle-light as in the day time. In the light of a lamp or a candle, blue sometimes appears green, and yellow objects assume a whitish aspect. The reason is that the light of a candle or of a lamp is not as pure a white as that of the sun, but has a yellowish tinge, and therefore, when refracted by the prism, the yellowish rays are found to predominate, and the superabundance of yellow rays gives to blue objects a greenish hue. The following experiment, as described by Sir D. Brewster, may further illustrate our subject: "Having obtained the means of illuminating any apartment with yellow light, let the exhibition be made in a room with furniture of various bright colors, and with oil or water-colored paintings on the wall. The party which is to witness the experiment should be dressed in a diversity of the gayest colors, and the brightest-colored flowers and highly-colored drawings should be placed on the tables. The room being at first lighted with ordinary lights the bright and gay colors of everything that it contains will be finely displayed. If the white lights are now suddenly extinguished, and the yellow lamps lighted, the most appalling metamorphosis will be exhibited. The astonished individuals will no longer be able to recognize each other. All the furniture of the room, and all the objects it contains, will exhibit only one color. The flowers will lose their hues; the

paintings and drawing, will appear as if they were executed in China ink; and the gayest dresses, the brightest scarlets, the purest lilacs, the richest blues, and the most vivid greens, will be converted into one monotonous yellow. The complexions of the parties, too, will suffer a corresponding change. One pallid, death-like yellow, like the unnatural hue which 'Autumn paints upon the perished leaf,' will envelope the young and the old; and the sallow face will alone escape from the metamorphosis. Each individual derives merriment from the cadaverous appearance of his neighbor, without being sensible that he is one of the ghastly assemblage."

From such experiments we might conclude that were the colors of the solar spectrum different from what they are, the colors which adorn the face of nature and embellish the landscape of the world would be of another aspect, and appear very different from what we are now accustomed to behold. Some of the distant stars appear to display light different in color from solar light; and hence some have concluded that the coloring thrown upon the different scenes of the universe may vary somewhat in different systems, and that, along with other arrangements, an infinite variety of coloring of scenery may be displayed throughout the immensity of creation. The different coloring, however, which these distant stars appear to exhibit may arise from complementary colors, which we shall soon come to consider. The atmosphere, in consequence of its refractive and reflective powers, is the source of a diversity of colors which frequently embellish and adorn the aspect of our sky. The atmosphere reflects the blue rays most plentifully, which is the cause of its blue aspect, and must, therefore, transmit the red, orange, and yellow more copiously than the other rays. When the sun and other heavenly bodies are at a high altitude their light is transmitted without any perceptible change to the earth's surface; but when they are near the horizon their light has to pass through an extended tract of dense air, and must therefore, be considerably modified by reflection before it reaches the eye of the observer. If the light of the setting sun, by thus passing through a long tract of dense air, be divested of its green, blue, indigo, and violet rays, the remaining rays which are transmitted through the atmosphere will illuminate the western clouds, first, with an orange color, and, then, as the sun gradually sinks below the horizon, the track through which the rays must pass becoming longer, the yellow and orange are reflected, and the clouds grow more deeply red, until at length the departure of the sun leaves them of a leaden hue, by the reflection of the blue light through the air. Similar changes may sometimes be seen on the eastern and western front of white buildings. From such atmospherical refractions and reflec-

tions those beautiful and varied hues are produced with which our western sky is gilded by the setting sun, and the glowing red which tinges the morning and evening clouds, until their ruddy glare is tempered by the purple of twilight, and the reflected azure of the sky. When a direct spectrum is thrown upon colors darker than itself it mixes with them, as the yellow spectrum of the setting sun, thrown on the verdant grass, becomes a greener yellow. But when a direct spectrum is thrown on colors brighter than itself it becomes instantly changed into the reverse spectrum, which blends with these brighter colors. Thus, the yellow spectrum of the setting sun thrown on the luminous sky becomes blue and changes with the color or brightness of the clouds on which it appears. The red rays of light being capable of appearing through thick and resisting media which intercept all other colors is likewise the cause why the sun appears red when seen through a fog ; why lamps at a distance, seen through the smoke of a large street, are red, while those near by are white. To the same cause it is owing that a diver at the bottom of the sea is surrounded with the red light which appears through the superincumbent fluid, while the blue light is reflected from the surface of the water.

Complementary, or Accidental, Colors.

When the eye is impressed with a brilliant light or color, after it has been removed, the retina of the eye remains for a short time impressed with a color which is usually complementary to the one first observed. Complementary colors mean any two colors which will, when combined, form white light ; in short, any two colors which contain red, yellow, and blue. Thus, a brilliant yellow light would leave upon the eye the impression of violet-colored light, composed of red and blue ; a green would leave a reddish violet ; a red a bluish green ; a black a white ; a white a black ; an orange a blue ; a blue an orange red ; indigo an orange yellow ; and violet a yellow green. This can be illustrated by placing some strips, say of red paper, in the form of a cross on a sheet of white cardboard. If the oxyhydrogen light is projected from a lantern with condenser lenses on to the red cross, and the spectator directed to watch it steadily, on suddenly removing the card with the red cross, and having another white card behind it, it will usually be noticed that nearly all those who are watching the experiment will exclaim that they see a green cross, faint green of course, but still quite sufficiently defined to enable them to determine that it is so. If instead of the red cross green be employed, red remains visible, and black, as already stated, becomes white.

These effects are described by Sir D. Brewster, under the name of "Accidental colors;" and he appears to regard them as synonymous with the term already explained, that is, complementary colors. He thus explains the phenomena; "When the eye has been for some time fixed on the red cross, the part of the retina occupied by the red image is strongly excited, or, as it were, deadened by its continued action. The sensibility of red light will therefore be diminished; and, consequently, when the eye is turned from the red cross to the white card, the deadened portion of the retina will be insensible to the red rays which form part of the white light of the paper, and consequently will see the paper of that color which arises from all the rays in the white light of the paper, but the red; that is, of a bluish green color, which is therefore the true complementary color of the red cross." "When a black cross is placed on a white ground, the portion of the retina on which the black image falls in place of being deadened is protected, as it were, by the absence of light, while all the surrounding parts of the retina, being excited by the white light of the paper, will be deadened by its continual action. Hence when the eye is directed to the white card, it will see a **white cross**, corresponding to the black image on the retina; so that the accidental color of black is white." For the same reason if a white cross is placed on a black ground and viewed steadily for some time, the eye will always see a black cross; so that the accidental color of white is black. The same author remarks: "It is not, however, necessary that the eye should be strongly impressed previously by some colored light, as the phenomena of accidental colors are sometimes seen without it."

He states that in order to see this class of phenomena, he found the following method the simplest and the best: "Having lighted two candles hold before one of them a piece of colored glass, suppose bright red, and remove the other candle to such a distance that the two shadows of any body formed upon a piece of white paper may be equally dark. In this case one of the shadows will be red and the other green. With blue glass, one of them will be blue and the other orange-yellow, the one being invariably the accidental or complementary color of the other. The very same effect may be produced in daylight by two holes in a window-shutter; the one being covered with colored glass, and the other transmitting the white light of the sky."

Mr. Rose, in a paper on "Persistence," in which he describes experiments devised and carried out by himself shows that with no color whatever to look upon, and only gazing on a white card, while the starry light falling on it is gradually reduced and restored, the

white appearance of light passes into the various gradations of colored light. He thus describes this very interesting experiment: "An intensely white card is held before the eye, whilst a strong light, falling on it, is gradually reduced and restored. As the light is reduced the whiteness passes into yellow orange, red, and sometimes thence into blue. Whilst at other times colors intermediate between the red and blue are apprehended, the gradual reduction of the light brings up the color by successive steps, and in reverse order to whiteness. All eyes, as might be expected, are not affected alike by these experiments; but all see whiteness passing into yellow, orange, and blue; and blue returning back in deep orange, yellow, and white. The restoration of the light is on the whole less satisfactory than its reduction, for when by reduction a deeply intense blue is obtained the light cannot, to some eyes, be restored slowly enough to prevent a sudden change to deep orange. The colors that succeed each other as the light is gradually reduced have none of the accepted relations between any given color and its complement. The white is not succeeded by thin blackness, the yellow by faint purple, or the orange invariably by blue; but the different hues do come up in an order that suggests the great probability that *what we name colors is only the various affection of the optic nerve by a greater or less quantity of light radiating from a focal point in an imperfect reflector.*" It is said the above experiment was the result of accident. Mr. Rose had been looking upon a white surface lying near a powerful gaslight, when his arm having caught the tap and reduced the light, his attention was drawn to a sudden change from white to red color.

Another experiment of great beauty and interest was also suggested to him by an accidental circumstance. He was observing the effect of flashes of intermittent, artificial light on a revolving disc, having twelve large circular black spaces, ranged equidistantly around the margin. It was broad day, and the window-shutters were closed to exclude the natural light. While the experiment was going on the shutter accidentally started open, and admitted a little daylight, when the remarkable appearance was presented of twelve blue circular spaces, lying upon a zone of bright orange. Mr. Rose regarded this at the time as simply the presentation of a complementary color, under singular conditions which kept it permanently before the eye; but as leisure afforded him opportunity to repeat the experiment, he soon began to perceive that he had taken far too limited and narrow a view. This misconception arose out of a fact connected with the painting of the discs. He found that lampblack alone would not give the depth and intensity required in the devices, and to remedy the defect he added a little indigo. The circular

spaces, to the eye, were certainly intense black, and nothing more; but he considered that they had a tendency to blueness, and that under the rotation they were reduced to a lighter blue, and drew after them trains of complementary orange, in the same way that a black fly, walking across a pane of ground glass, backed by gray light, is seen to draw a white spectrum after him.

But he dismissed this idea as soon as he found that absolute unmixed black produced the same effect, and that the nearer the artificial light approached to intensity of whiteness, the more decided and satisfactory was the result. But how is this effect to be explained? Mr. Rose goes on to say: "The diffused light of the zone is continually falling upon the eye; but the intermittent flashes find the negations or black portions always in the same areas, and hence from the spaces no part of the flash is reflected, whilst it mingles with, and adds to, the diffused light in the spaces between the negations. Now the diffused light is, we assume, intense light reduced by distribution to blueness; and in this blueness the negative spaces participate; but in the rest of the zone the flash brings up the light in such quality in relation to space as is necessary for the presentation of orange. We have more light from diffusion at the outer and inner edges than at the centre of the zone or ring, and hence the light blue at the inner margin, and the light blue, passing into green, at the outer margin. This common quality of the zone is shown in the negative spaces. But from the intervals between them there comes the diffused light variously affected by the flash, and conveying the graduated tints of orange." Mr. Rose thinks this explanation of the subject will appear reasonable, if the conditions of the action are thoughtfully considered. Eight circular spaces of absolute blackness produce under rotation and by persistence a nebulous ring. "If," he says, "this is to be viewed as a mixture of light and shadow, or of black and white, we cannot explain the manner of its affection by the intermittent light, which shows the apparently stationary negations as blue, and the remainder of the zone as orange. But if we regard the black spaces as utter absence of light, reducing the quantity of light for distribution over the zone, but giving it no quantity by admixture, all difficulty is at an end. A quantity of light is then understood to be diffused, over a certain space, whence it comes modified to blueness; and when this reduced light receives the impression of the flash, it is increased in relation to surface, and raised to orange."

In the "Edinburgh Journal of Science" Mr. Smith has described a very curious instance of the change of white light into complementary tints. In his directions for the performance of this exper-

iment he tells the operator to hold a strip of white cardboard upright about twelve inches from the eyes. The card may be six inches long, and a quarter of an inch wide. If the eyes are now fixed upon some object at a distance of ten or twelve feet behind it, so that the card becomes doubled, and a lighted candle is now placed close to the right eye, and shaded from the left one, the latter will see the white strip of card *green*, while the former will appreciate the complementary color or red. On changing the candle so that the light falls upon the left eye the phenomena are reversed. We shall conclude this part of our subject, on the persistence of vision and its illusions, by presenting a general summary of the effects. 1. *Persistence* is the retention of an image by the eye not for an absolute instant, but for an interval,—an interval sufficiently long for an object to pass over a succession of points, in all of which it will be apprehended by the eye at the same instant. For illustration, a lighted stick whirled round rapidly in a circle presents a ring of light, because the eye retains an impression of the light at any given point, until the stick has returned to the same point again. 2. *Simple Persistence* presents only illusions of the simplest character, as the commingling of the elements of white light, the composition of color, etc. 3. *Persistence under Conditions of Interrupted Vision* offers an indefinite variety of illusions, depending upon the fact that a disc in rapid revolution, presenting the points in the circumference only for an instant to the eye, is virtually stationary; and any object situated in these points is distinctly seen, because of its making no sensible advance during the exceedingly brief interval of its apparitions. 4. *Disc Action* presents the illusions of vision under various arrangements, in which discs revolving with different degrees of velocity, and bearing multiform devices, impress the eye with a number of images at virtually the same instant. 5. *Single Disc Action* is tolerably well known in its application to ordinary optical instruments, and as the vehicles for the amusements presented in the thaumatrope, etc. The single action has this advantage in connection with the thaumatrope and kindred devices, that it shows true form, and does not make anamorphoses or distorted figures; in one point of view confused, in another exact and regular. 6. *Double Disc Action* produces, under certain arrangements, an almost unlimited variety of illusions. The double disc movement, as arranged by Mr. Rose, consists of two wheels, one of which receives a disc bearing the devices, and the other a black disc perforated with a number of slots or slits. The wheels revolve in contrary directions, and their relative velocities can be varied at pleasure within certain limitations. In these illusions the aim is at something higher than a mere optical

toy; the double disc action will be more estimable since it presents the most interesting illustrations of recondite optical principles, and also examples of compound motion, multiplication, involution, and combinations of the most attractive and pleasing character.

Color is that property of light to which the universe is indebted for the beauties and sublimities with which it is adorned. It is color, in all its diversified shades, which presents to the view of intelligent beings that almost infinite variety of aspect which the scenes of nature display, which directs the eye and the imagination, and gives a pleasing variety to every new landscape we behold. Every flower which adorns our fields and gardens presents its various hues; every landscape presents its shrubs and trees of different degrees of intensity of verdure; and almost every mountain is covered with herbs and grass of different shades from those which are seen on the hills and plains surrounding it. In the rural districts during the summer nature is daily varying her appearance by the multitude and diversity of her hues and decorations, so that the eye rambles with pleasure over objects continually diversified, and extending on all sides as far as the sight can reach. In the flowers which deck every landscape, what an admirable assemblage of colors, and what a wonderful art in the disposition of their shades does nature display. Here appears a light pencilling of delicate tints; there they are blended in a manner surpassing the nicest rules of the most exquisite art. Although green is the general color which prevails over our earthly scene, yet it is diversified by a thousand different shades, so that every kind of tree, shrub, and herb, is covered with its own peculiar verdure. The dark green of the forests is thus easily distinguished from the lighter shades of corn-fields, and the verdure of the pastures.

The world of animated nature also displays a great variety of beautiful colors. The plumage of birds; the brilliant feathers of the peacock and the guinea-fowl, of the robin, the goldfinch, and the humming-bird, and the various embellishments of many species of the insect class, present to the eye in every region of the globe an interesting scene of diversified beauty. Nor is the mineral kingdom destitute of such beauties of color, for not only all crystals, and precious stones, but some of the roughest and unshapeliest stones and minerals, when polished artificially, display a mixture of the most delicate and variegated colors. Now all these beauties in the scene around us are owing to that property in the rays of light by which they can be separated into their primary colors. To the same cause are to be attributed those beautiful and diversified appearances, which frequently adorn the face of the heavens, the yellow, orange and ruby hues which embellish the sky at the rising and setting of

the sun, and those aerial scenes so frequently beheld in tropical climes, where rivers, houses, and mountains are depicted as rolling over each other along the circle of the horizon. The clouds, particularly in some countries, reflect almost every shade of color in nature; sometimes they are of a roseate hue; sometimes they appear like bands of deep vermillion: and sometimes like huge brilliant masses heaped one upon another and tinged with various hues; now they are white, like ivory; now as yellow as native gold. In short, color diversifies every scene with which we are acquainted, whether on the earth or in the heavens. It imparts beauty to the rainbow, to the coruscations of the Aurora Borealis, and gives a splendor and sublimity to the spacious vault of heaven.

But let us consider for a moment what the aspect of nature would be if instead of the beautiful diversity of embellishment which now appears on every side one uniform color were spread over the scenery of the universe. Conceive the whole of terrestrial nature to be covered with snow, so that no object on earth appeared of any other hue; and that the vast expanse of the sky presented the same uniform aspect; what would be the condition of human beings, supposing them existing in such a world? The light of the sun would be strongly reflected from every object within the bounds of our horizon, and would produce such illumination as would dazzle every eye. The day would exhibit a greater brightness than it now does; and our eyes, having become accustomed to it, might be enabled freely to expatiate on the surrounding landscape; but everything, though enlightened, would appear confused, and particular objects would scarcely be distinguishable. A house or a tree near at hand might possibly be distinguished on account of its elevation above the general level of the ground, and rivers, and valleys, and other hollow places, by reason of their being depressed below it. But we should be obliged rather to guess and conjecture as to the particular objects we wished to distinguish than be able to arrive at any certain conclusion concerning them; and if objects lay at a considerable distance from us it would be impossible for us with any degree of probability to distinguish one object from another. Notwithstanding the universal brightness of the scene the uniformity of color of every object would certainly prevent us from easily distinguishing them from one another. In such a condition human beings would be confounded, and friends and neighbors be at a loss to recognize each other!

The heavens, too, would wear a uniform aspect; neither the moon nor planets would be visible to the eye, nor those numberless stars which now shine with such brilliancy and adorn the nocturnal sky;

for it is by the contrast produced by the white radiance of the stars, and the deep azure of the sky, that those distant bodies are rendered discernible. Were they depicted on a snow-white ground they would not be distinguishable from that ground, and consequently would be invisible.

Of course, all that beautiful variety of aspect which now appears on our terrestrial scene,—the rich verdure of the fields, the dark green foliage of the stately forest trees, the rivers meandering through the valleys, and the splendid hues which variegates and adorn our gardens and meadows, the gay coloring of the morning and evening clouds, and all that variety which distinguishes the different seasons,—would not at all appear. As every landscape would exhibit nearly the same aspect, the poet, the philosopher, the antiquarian, the scholar, or the man of science, would have no inducement to visit distant countries to investigate the scenes of nature or the productions of art; and tours from one region of the earth to another would scarcely be productive of enjoyment.

The prevalence of any other single color would be attended with nearly the same results. Were a deep red to be uniformly spread over the scene of nature, it would not only be disagreeable to the eye, but prevent all distinction of objects. Were a dark blue or a deep violet to prevail, similar effects would follow, and the scene of nature would present a dismal and gloomy appearance. Even if all nature were arrayed in a robe of green, which is a more pleasing color to the eye, were it not diversified with the different shades which it now exhibits, every object would be equally undistinguishable. Such would be the aspect of nature and the inconveniences to which human beings would be doomed, were it that the light which shone upon them was without that intermixture of colors which now appears over the face of all nature, and which serves to discriminate one object from another. Even our domestic apartments could not be decorated in the least degree, and the articles with which they would be furnished would be almost undistinguishable, so that in discriminating one object from another, we would be as much indebted to the sense of touch as to the sense of sight. But worst of all would be the numerous delays, uncertainties, and perplexities to which we should be subjected, were we under the necessity every moment of distinguishing objects by trains of reasoning, and by circumstances of time, place, and relative position. An artificer, when commencing his work in the morning, with his numerous tools of nearly the same size and shape, would have to spend a considerable portion of his time before he could select those he wanted to use, or the objects to which he wanted to apply them;

and in every department of society, and in all intercourses of persons by travel from one place to another, similar inconveniences and perplexities would occur. People would have to spend one-half their time in uncertain guesses and perplexing reasonings respecting the real nature and individuality of objects, rather than in a consecutive train of thought, or a regular employment; and after all the perplexities and conjectures they must remain in the utmost uncertainty and ignorance of the thousands of scenes and objects which are now obvious through the instrumentality of colors.

For the existing state of things in the visible universe, and for thus enabling us to distinguish objects by such an easy and expeditious mode as that of color, which in a moment distinguishes every object and its several relations, we cannot but admire the wisdom and goodness of the Creator! We rise in the morning to our respective employments, and our tools, our books, and whatever is necessary for our subsistence and comforts, are at once discriminated. Without the least hesitation, and without any perplexing process of reasoning, we can lay our hands upon whatever article we require. Color clothes every object in its peculiar livery, and infallibly directs the hand in its movements, and the eye in its surveys and observations. But this is not the only end which is answered by the diversity of colors. They minister largely to our pleasures as well as to our wants. To those favored with a refined taste, as well as to almost every human being, the exquisite coloring of flowers, the delicate tints with which they are painted, the varied shades of green with which the hills and dales, the mountains and valleys, are arrayed, and that beautiful variety which appears on a bright summer's day on all the objects of universal nature, are sources of the purest enjoyment and delight. Color, too, as well as magnitude, adds to the sublimity of objects. Were the canopy of heaven of one uniform color, it would not produce those lofty conceptions, and those delightful and transporting emotions, which a contemplation of its august scenery never fails to inspire. The colors displayed in the solar light are common to all the globes which compose the solar system, and must necessarily be reflected in all their diversified hues from all objects on their surfaces. Some of the double stars appear to emit light of different hues, which is thought by some astronomers to arise from complementary colors. The larger star sometimes exhibits light of a ruddy or orange hue, and the smaller one a radiance which approaches to blue or green. There may, therefore, be some reason to conclude that the objects connected with the planets which revolve around such stars, being occasionally enlightened with suns of different hues, display a more diversified and splendid scenery

of coloring than is ever beheld in our world; and that one of the distinguishing characteristics of different worlds in regard to their embellishments may consist in the variety and splendor of colors with which the objects connected with them are adorned.

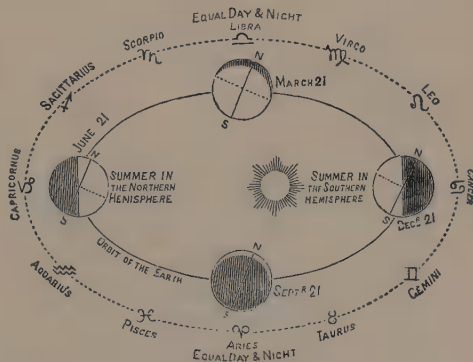
It need not be inferred from what has been said, that we intend to convey the idea that the light, or colors which human beings have experienced in any past time were ever different to what we find them now to be. We believe, on the contrary, that light has always been what it is now, and that it has always displayed a great variety of colors. Moreover, light, with its inherent colors, is a creation in the same sense as any other object is; and in the same sense as any other natural object, it is an eternally created thing; that is to say, it has always been and always will be, created. It is a new manifestation or combination of matter, as a man, or a tree, or any other natural object is a new manifestation or combination of matter. It is everywhere present in principle, and is always manifested wherever the conditions necessary for that manifestation exist. In this, as well as in many other arrangements in nature, we have a sensible proof of the presence and agency of that Almighty Intelligence in whom we live, and move, and have our being. None but an infinitely wise and beneficent Being, intimately present in all places, could thus so regularly create in us, by means of color, those exquisite sensations which afford us so much delight, and which unite us, as it were, to everything around us. In the variety of hues spread over the face of creation we have as real a display of the Divine presence as Moses contemplated at the burning bush. The only difference is, that the one was out of the common order of Divine procedure, while the other is in accordance with those permanent laws which regulate the economy of the universe. In every color which we contemplate we have a sensible remembrancer of the presence and benevolence of that Being whose spirit hath garnished the heavens and the earth, and by whose power and agency we are every moment sustained in existence. Oh that men would, therefore, praise the Lord for his goodness, and for his wonderful works to the children of men! He giveth rain to the evil and the good, and causeth his sun to shine upon the just and upon the unjust!

ON ASTRONOMY.

The object of the science of Astronomy is to explain the motions and magnitudes of the earth and the heavenly bodies, their various aspects, and other facts which have been ascertained concerning them. It is a science that has to do with our subject, since it illus-

trates the changes of place effected in the earth and the heavenly bodies by their motions; gives the mind a more expansive idea of the infinite Creator, and gives it to understand that it cannot possibly comprehend the mode of existence of that Being who is everywhere present in essence and power, amid such varied and complex changes and revolutions.

It will first be expedient for us to say a few words in relation to the apparent motion of the heavenly bodies during the day and night, and as to the form and motions of the earth, before proceeding to describe particularly the phenomena of the other heavenly bodies. When we look up toward the sky, we perceive an apparent concave hemisphere; placed at an indefinite distance from us, and surrounding the earth on every side. During the day the principal luminous object that appears in this hemisphere is the sun. In the morning we see him rise beyond the distant mountains or the extremity of the ocean; he gradually ascends the vault of heaven, and then declines and disappears in the opposite quarter of the sky. In the northern parts of the globe, where we reside, if, about the 20th of March, we place ourselves in an open plain at about six o'clock in the morning, with our face toward the South, the sun will appear to rise on our left, or due East, and at about the same hour in the evening he will set on our right hand, or due West. This time is called the *Vernal Equinox*, when day and night are equal. About the 21st of June he rises to our left, but somewhat behind us in the direction of the North-east, reaches a greater height at noon than on the 21st of March, and after describing a large circle in the heavens, sets on our right hand and still behind us, in the North-western quarter of the sky. This time is called the *Summer solstice*, or the time when the sun appears



This diagram of the seasons will tend to illustrate the subject more clearly. It shows the positions of the signs of the Zodiac, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces.

to stand still a few days, and then begins to retrace his steps. At this time the day is longest and the night shortest. At about the 23d of September the sun again rises due East, and sets due West, as on the 20th of March; and this is called the *Autumnal Equinox*, day and night being now again equal. At about the 21st of December, if we observe from the same position, we may see, without turning our eyes, the points at which he rises and sets. He rises in the South-east, ascends to a small elevation at noon, and sets in the South-west, after having described a very small arc in the heavens. This time is called the *Winter solstice*, when the sun seems to remain stationary for a short time, as it were, preparatory to his advancing to describe larger circles of the heavens. The day is now shortest and the night longest. Each succeeding day after this he appears to rise a little farther towards the East, for the stars which are seen to the Eastward of him appear every succeeding day to be nearer to the place where he is seen. All these various and successive changes are accomplished within the period of three hundred and sixty-five days, six hours, in which time he appears to have made a complete revolution round the heavens from West to East, at the rate of about one degree each day.

The moon is the next object in the heavens which naturally attracts our attention, and she goes through similar changes in the course of a month. When she first becomes visible at *new moon*, she appears in the Western part of the heavens, near where the sun went down, and she appears in the form of a crescent, having the horns pointed toward the East, the sun being now to the Westward of her. Every night she appears increased in size and removed to a greater distance from the sun, until after the lapse of about two weeks, she appears in the Eastern part of the horizon, just as the sun disappears in the Western, at which time she presents a round, full, enlightened face, and is called *full moon*. After this she gradually moves farther and farther Eastward, and her enlightened part gradually decreases, until at last she seems to approach the sun as nearly in the East as she did in the West, and rises only a little before him in the morning, in the form of a crescent, having its horns pointed toward the West, the sun being now to the Eastward of her. All these different changes may be traced by attending to her apparent positions from time to time with respect to the fixed stars.

Again, if on a winter evening, about six o'clock, we direct our view to the Eastern quarter of the sky, we shall perceive certain stars just risen above the horizon; if we observe the same stars at midnight, we shall see them at a considerable elevation in the South, having apparently moved over a space equal to one-half of the whole

hemisphere. On the next morning, about six o'clock, the same stars will be seen to set in the Western part of the sky. If we now look quite toward the South, we shall find that the stars there only describe very small arcs, rising but a little above the horizon, and setting again, after a short time, not far from the same point; the highest altitude attained at any time not being more than a few degrees. If we turn our eyes towards the North, we shall perceive a similar apparent motion of these twinkling orbs, but with this difference that a considerable number of them neither rise nor set, but seem to describe circles of greater or less diameter, round an apparently immovable point, called the North Pole. Near this point is situated the pole star, which in our latitude appears elevated about half way between the horizon, and the zenith, or point directly over our heads; and to a common observer seems fixed; but is found by the telescope to describe circles of about three degrees in diameter around the north polar point, from which the star is, therefore, really distant about one and a-half degrees. Thus, these Northern stars never set to us, but seem sometimes above, sometimes below, and sometimes to the East or to the West of the north polar point; the dimensions of the circles they describe depending upon their distances from the north pole; and the time they occupy in completing their circles is about 24 hours; or more accurately 23 hours, 56 minutes, and 4 seconds, that is, one day; and they all finish their revolutions in exactly the same period of time.

A person who has for the first time directed his attention to the heavens after having made such observations, will naturally enquire; whence come these stars that begin to appear in the East? Whither have those gone that have disappeared in the West? And what becomes during the day of the stars which are visible during the night? It occurs at once to an intelligent observer who is convinced of the roundness of the earth, that the stars which rise above the Eastern horizon come from another hemisphere, which we are apt to imagine below us, and when they set return to that hemisphere again; and that the reason why stars are not apparent during the day-time is not because they are absent from our hemisphere, or have ceased to shine, but because their light is obscured by the more vivid splendor of the sun. The fact of their presence in our hemisphere during the day is put beyond all doubt by the use of the telescope, which instrument, adapted to an equatorial motion, enables us to see many of the stars even at noon-day. We ourself have seen with the naked eye one of the planets at a pretty high elevation in the North-Eastern part of the heavens, on the forenoon of a day when the sun was shining brightly; its appearance at that time excited the attention of many

others also. From such observations we are led to conclude that the earth on which we dwell exists in empty space surrounded on all sides by the celestial vault, and that the whole sphere of the heavens has an apparent motion round the earth every twenty-four hours. Whether this motion be real or apparent is, however, determined by other considerations.

Although such general views of the nocturnal heavens, which every common observer may take, have a tendency to expand the mind, and to elevate it to the contemplation of an invisible Power by which such movements are conducted; yet such is the apathy with which the greater portion of mankind gaze at the heavens, that there are thousands who have occasionally viewed the stars for the space of fifty years, who are still ignorant of the fact that they perform an apparent diurnal revolution round our globe.

Again, if we contemplate the heavens with some attention for a number of nights in succession, we shall find that by far the greater number of the stars never seem to alter their position with respect to each other. If we observe two stars at a certain apparent distance from each other either North or South, or in any other direction, they



Fig. 93.—THE CONSTELLATION ORION.

will appear at the same distance, and in the same relative position, the next evening, the next month, and the next year. The stars,

for instance, which form the sword and belt of Orion, (which constellation may be seen during the winter in the Southern part of the heavens), present to our view the same figure and relative aspect during the whole period they are visible in winter, and from one year to another. And the same is the case with the stars of the Great



Fig. 94.

Bear, situated in the Northern parts of the sky,* and with all the fixed stars in the heavens.

There is, however, another fact with respect to the general appearance of the sky, which the observer can likewise verify for himself. Having fixed upon any bright star, let him observe it carefully on any evening at the exact time of its passing the meridian, or of its disappearance behind some conspicuous object, say a tree, or a church steeple. Let him observe it again on the following evening, and again after the lapse of a few days more, and he

* Figure 93 represents the constellation Orion; 94 represents the constellations of the Great Bear, the Little Bear, and the Pole Star. The seven stars in the lower part of the figure represent Ursa Major, or the Great Bear, sometimes known as the *Plow* and *Charles' Wain*. The seven stars in the upper part represent Ursa Minor, or the Little Bear, the largest star of which on the right hand side is the pole star. The two stars on the right hand side of the Great Bear are called the *Pointers*, because they point straight toward the north pole, and they are distant from each other about 5° . If a line connecting these two stars be considered as prolonged upwards to a considerable distance, about 29° , until it meet the first bright star, that star is the pole star, which is here represented at the highest part of the figure. About the beginning of November, at 6 or 7 o'clock in the evening, the Great Bear will appear near the north, at a low elevation above the horizon, nearly in the position represented in the figure. Let an observation be made about the middle of April, at 10 o'clock in the evening, the Great Bear will appear almost directly over our heads, *above* the pole star; and then we must conceive the line joining the two pointers as drawn *downwards* toward the pole star. At different times of the night, and at different seasons of the year, the Great Bear will appear to be in different positions with respect to the pole star, sometimes below, sometimes above, and sometimes to the East or West of it. But in all positions a line drawn through the pointers will direct the eye to the pole star.

will find that the star is a little earlier every day in arriving at the place. Thus, if it be on the meridian, or in a line with the marking object, at nine o'clock one day, it will be there about four minutes before nine on the next, and so on. It is owing to this that we see different constellations at different seasons of the year. Many of those which shine brightly on a winter's night are above the horizon in summer, during the day-time, and hence are invisible. In this way, we see by far the larger portion of the stars at some time or other of the year ; but just as those stars within fifty degrees of the north pole never set to us, so those within a similar distance of the south pole never rise at all in our latitudes. Among the most brilliant of the constellations thus hidden from us is that called the Southern Cross, and when travellers are going toward the southern hemisphere they anxiously await the first appearance of this constellation. As they approach the tropics and the equator the north pole star seems to sink lower and lower in the sky, and the number of stars which never set in our latitudes become less and less, till, when they reach the equator, the pole is in their horizon, and all the stars are seen rising in the east, remaining visible exactly twelve hours, and then setting in the western horizon. They all appear here also to travel in straight lines instead of in curves, as they appear to do in the north and south latitudes. By placing an artificial globe so that its axis is horizontal, and its pole in the horizon, one may obtain a representation of these phenomena.

But while the fixed stars never appear to alter their positions in relation to each other, we find, by a close inspection of the sky, another class of bodies, which regularly shift their positions ; sometimes these appear to move towards the east, sometimes towards the west, and sometimes to remain stationary. These bodies have received the name of *planets*, or wandering stars, in opposition to those which do not alter their position, and are hence called *fixed stars*. In our latitudes the planets are most frequently seen in the eastern and western, or in the southern quarters of the heavens ; and they are situated, with the exception of a few of the minor ones, in a belt called the zodiac, extending for nine degrees on both sides of the ecliptic (this is the apparent path of the sun) ; and hence the planets are easily found by observers. More than one hundred of these planetary orbs have been discovered, six of which were known in times of great antiquity, and only about five are visible to the naked eye. By long continued and careful observations of the aspects and motions of these planets, astronomers have determined that they all move round the sun as the centre of their motions, and form, along with the earth, one grand and harmonious system. This

assemblage of heavenly bodies, in connection with the earth, is termed the solar system, of which we shall exhibit a brief description after we shall have shown the ball of the earth to be in motion.

For a long time during the dark ages, and the infancy of science, the earth on which we live was considered the largest body in the universe. It was supposed to be an immense plane, diversified with inequalities in the shape of mountains and valleys, and stretching out to an unlimited extent on all sides, bounded by the sky. What was below this immense mass of land and water, and how it was supported, none ventured positively to tell; though some of the Christian fathers strenuously asserted that the earth was extended infinitely downward, and established on several foundations; a plain contradiction, for what is infinite cannot have a foundation. According to the ideas of some of the ancients, however, Atlas bore up the world on his shoulders; and many of the Hindoos of the present day assert that it is supported by a serpent and a tortoise; but it is clear that these attempted solutions of the difficulty, as the foundations of the Christian fathers, only remove it one step farther; for we should have to seek some support for the man and the serpent. Such, however, were some of the absurd and foolish opinions of those who viewed the system of the universe through a false medium, and who were ignorant of the facts and principles of modern science. It is only within the period of the last three centuries that the true figure and dimensions of the earth have been accurately ascertained. This figure is now found to be that of a sphere or globe, deviating, however, from the perfect spherical form, only so slightly that it could not be perceived in any model we could make of it. Suppose, for instance, we made a globe of thirty inches diameter, the difference between the polar and equatorial diameters would be only $\frac{1}{100}$ th of an inch, a difference too small for the keenest eye to detect. The real dimensions of the earth's diameters are found to be as follows: The greater, or equatorial, diameter, 7925½ miles; the lesser or polar, diameter, 7899 miles; showing a difference of a little over twenty-six miles. We do not know but that further investigations will make this difference even less, so that the earth may be regarded as a perfect sphere. That this is in reality the form of the earth will appear from such considerations as the following: when we stand by the sea shore on a calm day we easily perceive that the surface of the water is not quite plane, but somewhat convex or rounded; and if we are on the shore of an arm of the sea, three or four miles broad, placing our eyes near the level of the water, and looking along its surface toward the opposite shore we plainly see the water elevated about midway between our eyes and the opposite shore, so

as to prevent us seeing the objects which are near the edge of the water there. If we make the same experiment on a lake of three or four miles in extent, a small boat near the end of the lake may be seen by one who is at some height above the water ; but if we lay our eye near the surface the view of the boat will be intercepted by the convexity of the water, which proves the lake to be a small segment of a globe. On land, it is seldom a large tract of land can be chosen sufficiently level to answer the purpose of making such experiments, as even in large planes there are frequently undulations which materially alter the earth's natural convexity. Again, when we view a ship departing from the coast in any direction as it retires from our view we still see the masts and rigging of the vessel, when the hull has disappeared, and has sunk, as it were, beyond the boundaries of our sight. First we lose sight of the hull, then of the sails, and last of all of the topmast. On the other hand, when a ship is approaching the shore, the first part of it which is visible when at a considerable distance is the topmast ; as it approaches nearer the sails come into view ; and last of all the hull gradually comes within



Fig. 95.

Here only that part of the ship above the line A C can be seen by the spectator C : the rest of the ship is hidden by the swell of the curve D E.

the limits of our sight ; but the vessel will pass over several miles of the sea, from the time of our first perceiving the topmast until the hull appears in sight. In order that such observations should be made with accuracy it is requisite that a telescope should be used.



Fig. 96.

What is it then that prevents the hull of the ship, the largest part of it, from being seen when the topmasts are visible ? It is evidently the round or convex surface of the water, bulging up, as it were, between our eye and the lower part of the ship. When the ship is at a certain distance from us, when the hull has just begun to disappear from a person standing on the surface of the ground, the whole will be visible to an observer on an elevated building ; and if there be a lofty mountain near by the vessel will be seen from this after every portion of it is hidden from those on the beach. See Fig. 96.

This proves without doubt that the earth's surface is round ; and, in fact, a rough estimate of the size of the earth may be formed in this way. We have only to fix upon two elevations of equal height, as, for instance, marked places on the masts of two vessels, and ascertain the exact distance at which they are hidden from each other by the curvature of the earth. We must also know the elevation of the marked places on the masts above the level of the sea, and then by a simple proportion we shall obtain the diameter of the earth. The question is stated thus : As the height of the station of observation is to the distance of the visible horizon (which is half the distance between the two stations), so is this distance to the diameter of the earth. By another calculation it is found that two places elevated ten feet become hidden from one another at a distance a little short of eight miles ; that is to say, a straight line drawn from one of these to the other would just touch the earth midway between them. The curvature then may be set down as ten feet in $3\frac{1}{2}$ miles ; and the proportion is as follows : As 10 feet : $3\frac{1}{2}$:: $3\frac{1}{2}$ miles : the diameter of the earth. This gives 7828 $\frac{1}{2}$ miles for the earth's diameter, which is not far from correct. But the more accurate and philosophical mode of ascertaining its dimensions is by measuring an arc of the meridian, a process which enables us accurately to determine the length of a degree of latitude from the equator to the pole.

Now as such appearances as those we have mentioned, with respect to the water's surface and the ship, are observed on every sea and ocean on the face of the earth, it follows that the ocean at large is a convex surface, or a portion of a globe ; and the waters cover more than three-fourths of the earth's surface ; and if the ocean, constituting three-fourths of the earth, be globular, so also is the land, the remaining one-fourth, notwithstanding that the hills and the mountains form a few inequalities on its surface ; for the regions of the land are all nearly on a level with the ocean, with the exception of the ranges of elevated mountains. The height of the table-lands and mountain ranges bears such a small proportion to the actual diameter of the earth, that they in no way interfere with its general spherical outline. The greatest elevations are only about five miles, and there are but a few of these ; while the diameter of the earth is about 8000 miles. If then we would accurately represent these on a globe having a diameter of 16 inches, we must make them $\frac{1}{100}$ th of an inch high ; or they might be well represented by very small grains of sand. The thinnest tissue-paper would fully represent the elevation of table-lands ; and minute scratches, almost invisible without a microscope, would show the mountain gorges and valleys of rivers ; so for all ordinary purposes the earth is considered absolutely spherical.

On the other hand, were the surface of the sea a level plane the appearances would be very different. A straight line might be drawn from an object, as a ship, upon it, from any distance out, to the shore. In this case any object on the earth or sea would be visible at any distance, which was not so great as to make its appearance too small or faint to be perceived. An object would be visible at the same distance whether the eye were situated high or low. Sailors would not in such a case have to climb to the topmast in order to descry ships or other objects at a distance, for they could see them just as plain and at as great a distance from the deck, after the objects had come within visible distance. The largest and not the highest objects would be visible at the greatest distance. The topmast of a ship would first disappear, and the hull, as being the largest object, would be the longest visible; but this is contrary to all experience. The considerations already adduced are, therefore, clear and decisive proofs that the earth is not an extended plane, but a globular body; and it seems truly wonderful that such a conclusion was not generally arrived at until a comparatively recent date.

Moreover, that the earth is round from east to west is clear from the fact that navigation has long been conducted on that principle with the greatest precision, and that navigators have repeatedly sailed around it from east to west. They have set sail from England, crossed the Atlantic, rounded Cape Horn, sailed along the Pacific Ocean to the northern coasts of Australia, crossed the Indian Ocean, and, passing the Cape of Good Hope, have again arrived, by traversing the Atlantic, at the port whence they set sail. These experiments, therefore, show that the earth is round from east to west, but they do not prove that it is also round from north to south, for it has never been actually circumnavigated in that direction, owing to the obstruction caused to navigation by the immense masses of ice within the polar regions. Had we, therefore, no other proof of the earth's rotundity than this, we might be apt to suppose it somewhat resembling the shape of a cylinder; but that the earth is really round from north to south appears from the following considerations. When we travel a considerable distance from north to south, or from south to north, a number of new stars successively arise in the quarter of the heavens (whichever it may be) to which we are advancing, and many of those in the opposite quarter gradually disappear. For example, in sailing toward the south, when we approach the equator the brilliant constellation called the Southern Cross, before mentioned, which is never seen in our northern latitudes, makes its appearance; and if we go farther south the constellations of the Great Bear, Cassiopeia, and other stars, visible in our northern

sky, will entirely disappear, which could not happen if the earth were a plane in that direction; for in such a case all the stars of heaven would be visible in every point from the north to the south pole. Another corroborative proof of the earth's globularity is this. In excavating a canal of any length, in order to have the waters on a level, certain allowances require to be made for the earth's convexity. The slope required to be made on this account is about eight inches in the mile, thirty-two inches in two miles, and so on, increasing with the square of the distance. If the earth were a level surface no allowances of this kind would need to be made in order that the water in a long canal might stand on a level.

But another most evident and conclusive proof of the earth's rotundity is that afforded in the shape of its shadow. The earth is an opaque body, shines by reflected light; and, must, therefore, cast a dark shadow in the direction opposite to the sun; but the shape of this shadow can only be seen when there is some solid body on which it can be thrown. Now there is but one body which ever comes near enough to the earth to receive this, and this body is the moon. When, therefore, the lunar eclipse happens, if we watch the moon as it enters the shadow of the earth, and again as it emerges from it, we shall find that the dark line of the shadow on the moon's disc is *always curved* to an arc of a circle. The earth therefore must either be a globe or a flat circular disc, and at first sight we might incline to the latter view, and imagine, with some of the ancients, that we dwell on a flat surface, like the top of a round table. When, however, we remember that *in all cases* and *in every position* of the earth and moon at the time of an eclipse the shadow is *always circular*, we are assured that the earth must be globular, as no other figure could always cast a circular shadow.

It is to be presumed that after the sensible and undeniable demonstrations that have been given of the rotundity of the earth, none of our readers will have any doubts left that the earth in which we live is of globular form, but there may still be some who are not yet convinced that it moves round its axis, and with immense velocity, through the regions of space, in company with the other planets. On this subject, therefore, we shall now offer a few considerations tending to show that the earth we inhabit, however steadfast it may appear to the eye of sense, is really a moving body, and that it moves with a velocity far greater than we are accustomed to see around us. There are two different motions considered as connected with the earth; one by which it is viewed as turning round its axis every twenty-four hours, and producing the succession of day and night; and another by which it moves round the sun every year, bringing about the changes of the seasons.

We shall here chiefly illustrate those arguments by which its diurnal motion may be demonstrated, and its annual motion afterwards. In the first place then there is one thing of which all feel certain ; that is, that motion does actually exist, either in the earth or in all the heavenly bodies around the earth. We behold every day the sun apparently moving from the eastern to the western horizon. We observe also all the stars apparently moving in a body round the earth in the course of twenty-four hours, and in the manner described above. Such observations, which everyone has it in their power to make, clearly show, that there is motion somewhere ; and the question is, is this only apparent with respect to the heavens, or is it the motion of the earth that produces this appearance ? Let us suppose for a moment that it is the earth which moves ; what will be the rate of its motion in turning round its axis to produce the apparent revolution of the heavens ? For if the earth really revolves round its axis from west to east, the heavens will, of course, appear to revolve round us from east to west, just as when one is on board a steamboat on a river, and not noticing the motion of the vessel, he sees the trees and other objects on the bank, *apparently* moving in the opposite direction to that in which the vessel is *really* going. The same kind of appearances often happen to a person sitting in a railroad car when in motion ; one is apt to think the fields and fences, the whole side of the country, to be moving in the contrary direction to that of the cars' motion. The rate of the earth's motion will depend upon its magnitude. Now we know that the earth is a globe somewhat more than twenty-four thousand miles in circumference, and consequently in turning round every twenty-four hours some portions of its surface must move, at least, a thousand miles every hour. This is a motion far more rapid than has ever been produced in the smallest bodies by human art ; and, therefore, it may appear incredible to some that such a motion can exist in a globe of such vast dimensions as the earth. But if such persons deny that the earth thus moves then they *must admit* that the heavens move. There is no alternative, for motion actually exists either in the one or in the other. Now if the motion is to be considered as existing in the heavens, let us see what the rate of this motion must necessarily be.

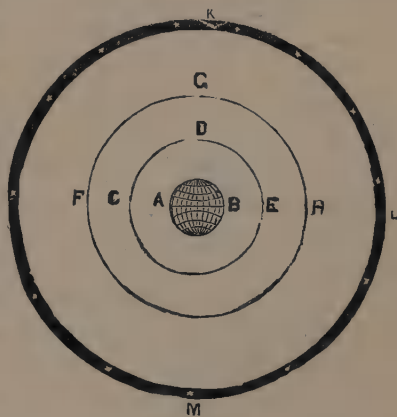


Fig. 97.

If a small globe of eighteen inches diameter and a globe of two thousand yards, or seventy-two thousand inches in diameter were each supposed to perform a revolution round its axis and to finish a rotation in the same time, this large globe would move with a velocity four thousand times greater than the other. In the annexed figure, if A B in the centre, represent the earth, then if the circle C E revolve around it in a certain time, and the other two circles revolve round it in the same time, it is certain that the circle F H must revolve with a quicker motion than the circle C E; and the circle I L with a still greater velocity, in proportion to its greater distance from the centre of motion A B. We shall consider then what would be the rate of motion of some of the heavenly bodies whose distances from the earth are known. The sun is ascertained to be somewhat near ninety-five millions of miles distant from the earth; and, consequently, were he to move round the earth every day, as he appears to do, he would move along a circumference of five hundred and ninety-seven millions of miles every day; that is, at the rate of about twenty-four millions of miles an hour, four hundred and fourteen thousand miles a minute, and six thousand nine hundred miles a second. Again the planet Uranus at its nearest point to the earth is more than one thousand seven hundred millions of miles distant; and consequently the circumference of its orbit is more than ten thousand six hundred millions of miles. If, therefore, this planet were supposed to move round the earth every day, its motions would be at the rate of four hundred and forty-five millions of miles in an hour, seven millions four hundred and twenty thousand miles in a minute, and one hundred and twenty-three thousand six hundred and seventy-seven miles every second. Again the nearest fixed stars are known not to be within 20,000,000,000,000, or twenty billions of miles off the earth; and consequently their daily circuit round our globe would measure 125,000,000,000,000, or one hundred and twenty-five billions of miles; this is at the rate of fourteen hundred millions of miles in the space of a single second, or the interval of time which the pendulum of a common clock takes in moving from one side to the other; stars at distances hundreds of times greater, of which there are many in our firmament, would move with a rapidity of hundreds of times swifter; and those still further removed from us in the depths of immensity with a velocity far exceeding human conception; yet all the stars of heaven appear to move round our globe every twenty-four hours. If the circle C D E of the figure represent the supposed diurnal orbit of the sun; F G H that of Uranus; and I K L M that of some of the

fixed stars ; then it is evident that in proportion to the distance of the body from the earth will the velocity of its motion be, if it be supposed to move round the earth.

If, therefore, there be any reader disposed to reject the motion of the earth because it is inconceivable he must necessarily admit of motions ten hundred thousand times greater and far more incomprehensible ; more especially when it is considered that the bodies in the heavens to which we have alluded are incomparably greater than the globe of earth on which we live ; the planet Uranus being eighty times, and the sun more than one million three hundred thousand times larger than the earth, and the fixed stars on an average as large as the sun. Such a rate of motion in such a number of magnificent globes appear altogether overwhelming, incomprehensible, and incredible.

The question, then, that is to be decided is, which of the motions to which we have referred is the most probable,—the motion of the earth or that of the heavens ? Is it really necessary that the whole universe, composed of sun, moon, planets, comets, stars, and nebulae, should move round our globe with such astonishing velocities in order to produce the alternate succession of day and night on the earth ? Reason says that it is not. It would contradict all our ideas of the simple and reasonable operations of nature, and of the intelligence of the Deity. The succession of day and night can be accomplished by a simple rotation of the earth on its axis, which is found to *completely account* for all the apparent diurnal revolutions of the celestial bodies. This is understood to be the case with the other planets of the solar system. The planet Jupiter is fourteen hundred times larger than the earth, and is said to move round its axis in less than ten hours, at the rate of 28,000 miles an hour, which is a velocity twenty-eight times greater than that of the earth, supposing the latter to move round its axis. The planet Saturn is about a thousand times larger than our globe, and it is said to revolve round its axis in ten hours and a-half, at the rate of 24,000 miles an hour in those places near its equator. To a spectator then, placed on these planets, the heavens would appear to revolve around him every ten hours, as they appear to us to revolve every twenty-four hours, but with an apparently more rapid motion ; while he, himself, might suppose, as we are apt to do, that the planet on which he is is really at rest. The earth, therefore, must be considered as revolving round its axis, in accordance with the revolutions of the other planets of the system to which it belongs ; and to suppose otherwise would be in opposition to all the laws which govern the material universe, and

would distort all our ideas of the harmony and order of the operations of nature.

Another consideration which demonstrates the diurnal motion of the earth is this: that such a rate of motion in the heavenly bodies as has now been stated would shatter the material universe to atoms. Were a ball of soft wood projected from a cannon at the rate of 800 miles an hour, in a few moments it would be reduced to splinters; and hence the forage and other light substances projected from a piece of ordnance are instantly torn to pieces. What then might be supposed to be the consequence, were a body impelled through the etherial regions with a velocity of a hundred thousand millions of miles in a minute, as multitudes of the stars behaved to be, were the earth at rest in the centre of the universe? It would undoubtedly reduce to atoms the most solid bodies in existence, though they were composed of substances harder than adamant.

Another corroborative argument which astronomers bring forward in support of the motion of the earth is this: that there is no instance known in the universe of a larger body revolving round a smaller one. We do not find, say they, such planets as Jupiter and Saturn revolving round their satellites; but all these satellites, which are much smaller than their primaries, perform their revolutions around the latter as the centre of their motions. The earth, which is fifty times greater than the moon, does not revolve round her, but that nocturnal luminary regularly revolves round the earth. The sun does not revolve round the planets Mercury or Venus, which are thousands of times less than that luminary, but they invariably revolve around him as their centre of attraction, light, and heat. As the sun is over one million three hundred thousand times larger than the earth it cannot, therefore, be supposed for a moment that such an enormous globe would revolve with such an inconceivably rapid motion round so inconsiderable a ball as the earth, and much less that the whole universe should revolve around it every day. Were the earth not revolving around its circumference every day there would be an infraction of all the laws which are known to govern the system of universal nature; and, therefore, it is absolutely necessary to admit its motion in order to direct our views and to become fully convinced of the systematic order and harmony of the operations of universal nature. What would be thought of a machine (if such could be conceived to be constructed) as large as the city of London, or any other large city, bearing a huge lamp near its centre, and revolving daily round a little ball of one inch in diameter, suspended in empty space, merely for the purpose of giving light and

heat to the surface of this little ball, when, at the same time, a revolution of the ball round its axis would answer the same purpose? The designer and constructor of such a system, however ingenious he might be thought by some for his great contrivance, would justly, by all wise men, be considered insane for having so disproportioned means to ends in the accomplishment of his object. Such a scheme, however, absurd as it seems, would not be half so preposterous as to suppose the vast universe to turn round so inconsiderable a ball as the earth to produce the alternate succession of day and night, when the same object could be effected by the earth's simply revolving round its axis once in twenty-four hours. But the whole system of universal nature is proportionate as to its constituent parts, and their operations; none of its parts, are unnecessary; none of its operations take place inconsistently with infinite intelligence and wisdom; and its operations all appear simple and reasonable when rightly considered. Now, all these supposed inconsistencies and impossibilities, which we have been considering, are at once got rid of, and complete, universal harmony and order restored, by the admission of the rotation of the earth round its axis every day.

Circles, Degrees, etc., explained.

If we refer to an ordinary terrestrial globe, such for example as those used in schools and colleges, we shall find that there are several circles drawn upon it, and we shall also observe that these are of different sizes, those called parallels of latitude near the poles and the polar circles being much smaller than those nearer the circle called the equator. These circles are accordingly divided into two classes, called respectively great and small circles. Great circles are those whose plane passes through the centre of the globe, so that they divide it into two equal portions; and, assuming the earth to be a perfect sphere, all these great circles will be exactly equal. All other circles are called small circles. The most important of the great circles is the equator, which is an imaginary line drawn round the earth, equally distant from the north and south poles, and therefore dividing the globe into two equal halves, called the northern and southern hemispheres. If now we conceive the plane



of this circle to be extended to the sky, we shall have a great circle of the heavens, known as the *celestial equator*, or more usually the *equinoctial*. This latter term is derived from two Latin words signifying "equal" and "night," and is applied to it because when the sun appears to be on this line it shines equally on both hemispheres; and day and night are then of equal length in all parts of the earth, the sun being above the horizon at every place for about 12 hours, and below it for about the same length of time. The days on which this happens are the 20th of March and the 23d of September; and by counting the days between these dates we shall find that in the northern hemisphere the summer is a few days longer than the winter; or in other words, that the period during which the sun is north of the equator is a few days longer than that during which he is south of it.

The sun's apparent path is not, however, along the equinoctial, but in a great circle, inclined to it at the present time at an angle of about $23^{\circ} 27' 30''$, and known as the *ecliptic*. Round this the sun appears to travel, performing the complete circuit of it in the space of one year. The space extending for 9° on both sides of the ecliptic, and thus constituting a band or zone 18° wide, is known as the *zodiac*; and within this space, as we have already explained, all the planets, with the exception of a few of the minor ones, are constantly found; so that we can always tell somewhat of the position in which they are. The zodiac is divided into twelve equal portions, each containing 30° , and the stars in these spaces are mapped out into the constellations known as the "signs of the zodiac," which we shall notice hereafter.

As we shall have frequent occasion to speak of degrees it is well that it be clearly understood what is meant by a degree, and the mode in which it is measured. It is evidently necessary for us to have some means of measuring the distances of the heavenly bodies from one another, and this can only be done by measuring the angle which imaginary lines, drawn from them to our eye, subtend. By a little consideration we shall find that it is in the same way we form our estimate of the dimensions of ordinary objects around us, and hence when we bring them nearer to our eye they appear larger, because the rays coming from their extremes to our eye contain a larger angle. Now we want some means of measuring and expressing in words the angle thus contained, and this we do by means of degrees and fractions of a degree. A degree then is the 360th part of a circle; that is, if we draw a large circle on paper, for example, and divide its circumference into 360 equal parts, and then draw straight lines from these divisions to the centre of the circle, the

angle contained between any two adjacent lines will be just one degree. On any circle we can draw on paper these divisions will necessarily be very small; when, however, we deal with a globe like the earth we find that a degree at the equator measures about 69 miles.

In a right angle there are, of course, ninety degrees, and if we can make a triangle with three equal sides, each angle will contain just sixty degrees. A degree is divided into sixty parts called minutes (*minute* parts); each of these is divided into sixty parts, called seconds; and in more delicate and accurate observations each of these is again divided into sixty parts, called thirds. These divisions are usually expressed by the signs for degrees ($^{\circ}$), minutes ($'$), seconds ($''$), thirds ($'''$); thus $16^{\circ}, 37', 5'', 15'''$. As a general guide to us in estimating approximately the distances or dimensions of the heavenly bodies it will be expedient to remember that the apparent diameter of the sun or moon is about half a degree; the distance between the pointers in the Great Bear is six degrees, and that between the pole star and the pointer nearest to it about twenty-four degrees. By means of an accurately graduated semi-circle we can easily measure any angle, and ascertain the number of degrees it contains.

We have stated above that the inclination of the ecliptic to the equator, or, as it is termed the "obliquity of the ecliptic" is nearly $23\frac{1}{2}$ degrees. This amount, however, is not constantly the same, but varies a little in the lapse of centuries. The rate of this variation is very slight, being less than $1'$ in 100 years, and it is found that it can only take place within very narrow limits. At present it is decreasing, but before it can have deviated as much as a degree and a-half the causes producing it will have been so modified as to act in a contrary direction, and increase the inclination again. All through astronomy instances are met with of these slow and gradual variations; but all are confined within very narrow limits, and instead of tending to a total change in the status of the earth or the system to which it belongs, they tend to the permanency of the system.

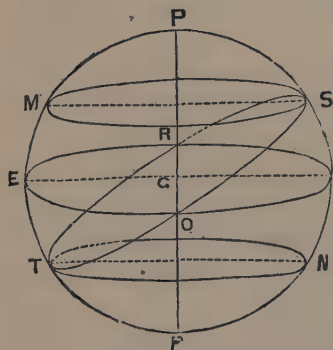
Now since these two great circles are thus inclined there must be two points in which they intersect one another, and these are called the equinoctial points, or the vernal and autumnal equinoxes. One of these is the first degree in the sign *Aries*, and the other the first in *Libra*. The first of these, or the vernal equinox, is the most important, as it is taken as the fixed point to be employed in measuring distances from, when we want to indicate the place of any body. We then take the equinoctial or equator as our base line, and first of all measure the distance of any star north or south of that. On a

terrestrial globe parallels of latitude, are drawn at distances of ten degrees.* It must be remembered that when we speak of degrees of latitude what we really mean is the inclination, which a straight line drawn from the place to the earth's centre would have to the plane of the equator. A degree is a measure of an angle, and not of a distance. It is well that this point should be clearly understood, as mistakes often arise through want of understanding it. Some folks will say, "a degree equals somewhat over sixty-nine miles," when what they really mean is that at the equator two lines meeting at the earth's centre, inclined to one another at this angle, would include between them a portion of the earth's surface of that length. On Jupiter, or any globe larger than the earth, the amount thus subtended at the equator would naturally be much greater; and on the other hand, in any small circle which we may draw on a piece of paper there is still 360° ; each degree, therefore, is very minute.

In astronomy, the distance north or south of the equinoctial is called the *declination* of a heavenly body. If now we draw another great circle passing through the poles, and also through the star, it will intersect the equator in two places, and the one of these on the same side as that on which the star is situated will furnish us with the other distance required.

If we examine the equinoctial on a celestial globe, we shall find that it is divided into degrees from 0° , to 360° , reckoning from east to west, the starting point being the first point of Aries.

The great circles to which we have referred, as passing through the poles perpendicular to the equator, are called *meridians*, and any number of them might be drawn; usually, however, twenty-four are drawn on the globe, their distance apart being fifteen degrees. They are then frequently termed *hour lines*, as the firmament seems to move just the interval between two of them in the space of an hour.



* In figure 98, the line PP represents the earth's axis, that is, the diameter of the sphere passing through the poles PP, and the centre C. The great circle EQ represents the equator, the great circle ST the ecliptic; the points R and O, where it intersects the equator, are called the nodes, and also the equinoctial points; and the points S and T, its farthest points north and south of the equator, are called the solstices; respectively the summer and winter solstice. The two small circles MS, and TN, parallel to the equator, are called the tropics, that to the north the tropic of Cancer; and that to the south the tropic of Capricorn. Now terrestrial parallels of latitude are small circles drawn parallel to the earth's equator; while celestial parallels of

latitude are drawn on the celestial globe parallel to the ecliptic. The two great circles MPE, NPT, and RPO, QOP (if the latter be conceived as a great circle at right angles with the other), are called respectively the solstitial and equinoctial colures.

We can obtain a clearer idea of these meridians by taking the globe out of its framework, and letting the brass meridian be free to turn round on its poles; we can then bring it over any star or place, and it will represent the meridian of that place. We shall likewise be able to see on the equator, the distance of its intersection from the first point in Aries. This distance is known as the *right ascension*, usually abbreviated thus, R. A. Thus, we see the way in which the position of a star is determined, the two measures being its right ascension and its declination. Suppose, for example, we wish to point out the place of a star in the tip of the tail of the Great Bear, we first find it on the globe, and bringing it to the brass meridian, we shall find that its elevation above the equinoctial is very nearly 50° , this is its declination. We now look to the equinoctial, and find the point of it directly under the meridian is 204° , or 13 hours, 36 minutes, from Aries; and thus we assign its place as 50° north declination, and 204° right ascension. In a similar way when the right ascension and declination are given, the star can be found.

If we examine a celestial globe we shall find that though the mark γ , signifying the commencement of the sign Aries, is placed at the intersection of the equinoctial and the ecliptic, yet the portion of the zodiac commencing at that sign is in reality occupied by the constellation *Pisces*. The stars forming Aries are moved 30° to the east, occupying the place assigned to Taurus, and all the other zodiacal constellations are moved one sign to the eastward. The cause of this is the precession of the equinoxes, which was first discovered by Hipparchus in the second century B. C. The points of intersection of the equator and the ecliptic, or as they are usually termed the *nodes*, do not remain constantly in the same place, but are slowly moving toward the west, that is in a retrograde direction. This was first observed by noticing that the right ascensions of all stars were slowly and uniformly increasing. This could only be accounted for in one of two ways; either they must all be slowly moving forwards, or the point from which we measure their right ascension must be moving backwards. The latter of these explanations, being by far the most simple, has been adopted. The rate of this motion is but slow, so that its effect on the position of the stars from year to year can only be ascertained by the most careful and delicate observations. When however, we compare the position of a star with that assigned to it by observers a few centuries ago we soon become aware of the change. The most careful observations fix the annual amount of this motion at $50'' 2'''$; so that the time occupied by the nodes in making a complete circuit of the heavens would be a little more than 25,900 years.

* By reckoning backward it is found that the constellations and the

* In the regress of the nodes from 0° Aries to 181° in *Libra*, and then again to 9° Aries, those climatic changes are occasioned which at certain stages are so disastrous to life. The gradual progress of those changes enables the species to seek more congenial latitudes. Formerly the nodes were generally said to retrograde $54'$ in a year, or 15° in 1,000 years.

signs of the zodiac coincided with one another about the year 370, B.C. Besides this motion of which we have spoken, there is another of much smaller amount, which is known as *nutation* or the nodding of the pole. It arises from the circumstances that the earth's distance from the sun varies at different times of the year, and thus the amount of precession varies slightly from day to day. The effect of this variation is to cause the pole to describe, in the course of about $18\frac{1}{2}$ years, a very small ellipse, the longer axis being about $18\frac{1}{2}''$, and the shorter nearly $14''$. This motion, combined with the other, produces a vibratory or undulating movement of the pole; it is only, however, in very accurate observations that this has to be taken into account. One important effect of the precession of the equinoxes is to change the pole-star. That at present known by this name is distant about $1\frac{1}{2}^\circ$ from the true pole; its distance is, however, gradually diminishing, so that in the course of years it will be within half a degree, and it will then commence to recede from it. In about 12,000 years it is estimated the brilliant star Vega, in the constellation Lyræ, will be very close to the pole, and serve as a pole-star.

There are also two other points in the ecliptic especially distinguished, and known as the *solstitial points*. These are situated midway between the nodes, and are at the commencement of the signs Cancer and Capricornus. The term solstitial is derived from the Latin *sol*, the sun, and *stare*, to stand, and is applied to these points, because when the sun reaches them it has attained its greatest north or south declination, and appears to stand for a few days before commencing to retrace its steps. Two great circles are drawn on the celestial globe, passing through the poles, the one passing through the equinoctial points, and the other through the solstitial points; and these are distinguished as the equinoctial and solstitial *colures*. They divide the ecliptic into four equal portions, and mark the divisions of the seasons of the year. The days on which the sun is at the solstices are the 21st of June, and the 21st of December; and these are respectively the longest and the shortest days.

Two small circles, parallel to the equator, and passing through the solstitial points are called the *Tropics*, that to the north being distinguished as the tropic of Cancer, and that to the south as the tropic of Capricorn. These, however, are of more importance in the use of the terrestrial globe than in that of the celestial. There are also two circles situated at a similar distance from the poles which mark the limits of the polar regions, from which the sun is sometimes hidden for more than a complete day; that to the north is called the Arctic, and that to the south the Antarctic, Circle.

The most usual way of describing the position of any star in the

heavens is by giving its declination and right ascension, as described above, the distances being reckoned from the equinoctial. Sometimes, however, these distances are reckoned from the ecliptic, and are then called the latitude and longitude. Parallels of latitude, circles parallel to the ecliptic, are frequently drawn on celestial globes to enable the latitude to be found without difficulty; the pole of the ecliptic is, of course the centre of these circles. Celestial longitude, as right ascension, is reckoned from the point Aries, and like it, is reckoned only in one direction from 0° to 360° . Terrestrial longitude, on the other hand, is reckoned from 0° to 180° east or west. Celestial longitude, therefore, measured from the point Aries on the ecliptic, corresponds to right ascension measured from the same point on the equinoctial; and celestial latitude measured from the ecliptic north or south, corresponds to declination measured from the equinoctial.

The Horizon.

As we shall have sometimes to speak of the *horizon*, it will be well for us distinctly to state what we understand by it, as sometimes there is a little confusion on this matter.

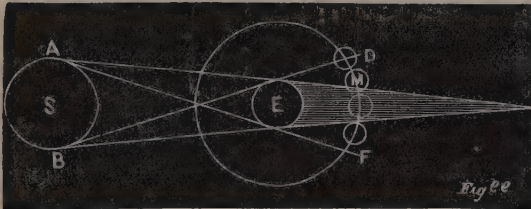
The *rational* or true horizon is an imaginary plane drawn through the centre of the earth, so that the line, where it cuts the surface, is everywhere equidistant from the observer. If we take an orange or an apple and divide it into two equal portions, or place a ring round it, so as to be midway between the *eye* and the *stalk*, it will represent the horizon. In an ordinary celestial globe, if the poles be elevated to the latitude of the place, the situation of the wooden horizon will correspond with that of the rational horizon to the observer. Thus, it will be seen that if this plane be extended on all sides to the sky it will divide it into two exactly equal hemispheres, one of which will be visible to the observer. There is, however, another sense in which the word horizon is used. When we ascend any height we see a line all around us where the earth and sky appear to touch; this is called the *sensible* or visible horizon. At sea or on a level plain this will appear to be a perfect circle; on land the elevations of the country usually interrupt the outline; still we can perceive that it is of a circular form, and that our point of observation is situated in the middle of it. The size of this circle increases with our elevation above the earth. Hence, when a sailor wants to know if any vessel is in sight, he ascends to the mast-head, where his view is much more extensive than it is from the deck of the ship. In the same way, if we ascend a high mountain, we gain a very extensive

view of the surrounding country. If we could place ourselves at a great distance from the earth, as for instance, on the surface of the moon, we should see just one half of the globe of the earth, and the rational and sensible horizon would then exactly coincide. This, of course, cannot be, and the highest elevation ever yet reached by man, or that in all probability ever will be attained, is so small, when compared with the earth's diameter, that only a small portion of our globe has ever been visible at once.

The following general rule will enable us approximately to calculate the distance of the visible horizon when we know the height of the station of observation. Express the height in feet and increase it by a half; then extract the square root, and this will give the distance in miles. Thus, if a building be 24 feet high, we then add 12 feet to it, making it 36, the square root of which is 6. The visible horizon is, therefore, distant six miles.

Eclipses Explained.

A dark shadow is occasionally seen to move across the face of the moon which obscures her light, and gives her the appearance of tarnished copper. Sometimes this shadow covers only a small portion of her disc - at other times it obscures the whole of it for an hour or



two, and its margin always appears in the form of the segment of a circle. This phenomenon, which happens on an average about twice every year, is termed an *eclipse of*

the moon. It is produced by the shadow of the earth falling upon the moon, when the sun, the earth, and the moon are in the same straight line; the earth being interposed between the sun and the moon; and this can only happen at the time of *full moon*. Sometimes the moon appears to pass across the disc of the sun, when her dark side is turned toward the earth, covering his disc, either in whole or in part, and intercepting his light from a certain portion of the earth. This is called an *eclipse of the sun*, and can happen only at the time of *new moon*, when the moon is interposed between the sun and the earth. In a total eclipse of the sun, which seldom happens, the darkness is so striking that some of the planets, and occasionally the larger stars, are seen and the inferior animals appear struck with terror.

The theory of lunar eclipses will readily be understood by reference to the annexed figures. In figure 99, S represents the sun and

E the earth, whose shadow is a long cone reaching into space. This dark shadow is called the *umbra*, and it gradually shades off into the *penumbra*, which is bounded by the lines B D, A F, and tapers toward the earth instead of away from it; M represents the moon revolving round the earth, and on its journey it sometimes passes through the dark cone and becomes for a time invisible. The commencement is marked by a faint shade, beginning to creep over the east side of the moon's disc. This is the first contact with the penumbra. As the moon travels onwards it enters the umbra, and the east side of its disc then becomes almost invisible. When fully immersed in the umbra, the moon may usually be feebly seen, and appears of a ruddy hue. The duration of a total eclipse of the moon may be as great as 1 hour

50 minutes. This is when the moon passes directly through the middle of the umbra. At other times it passes near the edge, and is then obscured for only a short period. When it passes through the centre of the shadow the total duration, from the first contact to the last, may be $5\frac{1}{2}$ hours.



Figure 100 shows at one view the phenomena of both lunar and solar eclipses. The solar eclipse represented here is an annular one, as the shadow of the moon terminates at *m* before it reaches the earth. A moment's careful inspection of this diagram will show that an eclipse of the sun can only take place at the period of the new moon, as the enlightened hemisphere is turned away from the earth; and that an eclipse of the moon, on the other hand, can only occur at full moon. The reason why eclipses do not happen at every new and full moon is that the moon's orbit is inclined to the earth's orbit at an angle of $5^{\circ} 9'$; so that during one half of its journey, the moon is below the plane of the ecliptic, and in the other above it. Now the earth's shadow is in the same plane as its orbit, and hence at the period of full moon the shadow may be above or below the moon, and in either case no eclipse will occur. The points in which these planes intersect are

known as the *nodes*, and hence there is an eclipse of the moon whenever a full moon happens at or near one of the nodes. In a similar way a solar eclipse occurs when the moon is near one of the nodes at the time of new moon. The position of the nodes of the moon's orbit is continually changing, at the rate of $19^{\circ} 20' 1.3$ minutes in a year; so that they perform a complete revolution in a trifle less than 18 years and 219 days. After an interval of 346.62 days, they come again into the same position in regard to the sun; and this period is called a *synodical revolution of the node*. Now it happens that 19 of these periods are almost exactly equal to 223 synodical revolutions of the moon; so that after this interval the sun, earth and moon, are again almost in the same relative position and the same series of eclipses is therefore repeated. This period of 6,585 days, or 18 years and 10 days, is called a *cycle of the moon*. It was known to the ancients and called the *Saros*, and by means of it eclipses were roughly calculated before any great progress had been made in the science of astronomy.

Conjunction and Opposition.

When a heavenly body is said to be in *conjunction* it is meant that the body is in a line with the sun and the earth, either between the earth and the sun, or having the sun interposed between it and the earth. When the body is between the earth and sun it is in its *inferior* conjunction; when on the other side of the sun from the earth it is in its *superior* conjunction. When a body is said to be in *opposition* it is meant that it is in a line with the sun, and the earth, the earth being interposed between it and the sun. The planets whose orbits lie between the earth's orbit and the sun, Mercury and Venus, have each two conjunctions, one inferior, or when either of them happens to be in a line between the earth and the sun; the other superior, or when they are in that part of their orbit that lies beyond the sun from the earth, in a line with the earth and sun; but these have no opposition. The superior planets, or those whose orbits lie without that of the earth have each one conjunction, the superior, and one opposition. The moon, whose movements are round the earth as a centre, and always accompanying the earth in its journey round the sun, has one conjunction, at new moon, the inferior; and one opposition, at full moon.

Proofs of the Earth's Annual Motion.

Now the *annual* motion of the earth and its position in the solar system are proved and illustrated by such considerations as the following: That if this motion did not exist, the motions of all the

planets would present a scene of inextricable confusion, consisting of direct and retrograde movements, and looped curves so anomalous and irregular as to be altogether inconsistent with anything like harmony, order, or intelligence: That Mercury and Venus have two conjunctions with the sun, but no opposition, which could not happen did not the orbits of these planets lie within that of the earth: That Mars, Jupiter, and all the other superior planets, have each their conjunctions with, and oppositions to the sun, which could not take place unless their orbits were exterior to that of the earth: That the greatest elongation (apparent distance) of Mercury from the Sun is only about 29° , and that of Venus 48° ; but if the earth were the centre of their motions, as the Ptolemaic system, and some other systems suppose, they might sometimes be seen 180° from the sun, or in opposition to him, which never happens: That some of the planets appear much larger and brighter at some times than at others on account of their different distances from the earth; but on the other hypothesis, their brilliancy and apparent size would be always about the same: That Mercury and Venus in their superior conjunctions with the sun, are sometimes hid behind his body, and in their inferior conjunctions sometimes appear to pass across the disc of the sun like round black spots, which would be impossible according to the Ptolemaic system: And in short, that the times in which the conjunctions and oppositions, stations (or when the planets are in that part of their orbit in relation to the earth and sun in which they appear to be stationary), and retrogrations (or when the planets are in that part of their orbits in relation to the sun and earth, in which they appear to go backward), happen are not such as they would be if the earth were at rest in the centre of their motions, but precisely such as would happen if the earth move along with all the other planets in the stations and periods assigned them in a system which has the sun for its centre. For as the sun is intended to cheer and irradiate surrounding worlds, it is most fit that those agencies and influences should proceed from the centre of the system from which they are communicated in an uniform and equable mode to the planets in every part of their orbits. Were the earth the centre of the system and the sun and planets revolving around it, the planets, when nearest the sun, would be scorched with excessive heat; and when farthest distant would be frozen with excessive cold.

There is another potent consideration by which the earth's *revolution*, and its position in the system, are demonstrated, and that is that the inferior planets Mercury and Venus, when viewed through moderately good telescopes, are found to assume different phases in different parts of their orbits. Sometimes they appear as a crescent,

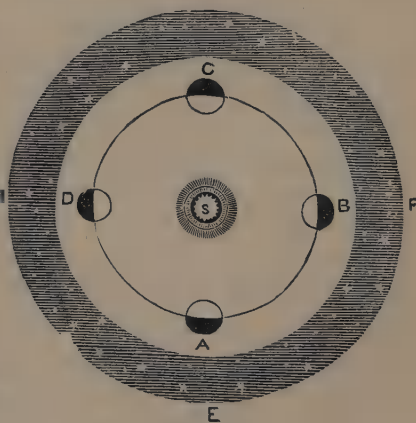
sometimes with a gibbous phase, sometimes like a half moon, or having a full enlightened hemisphere, which could not happen if they revolved around the earth as their centre of motion, and if the earth were not situated in an orbit exterior to theirs. This can be illustrated with peculiar effect by means of an equatorial telescope and a planetarium. Having placed the Earth and Venus in their true positions on the planetarium by means of an ephemeris (a little book showing the positions, etc., of the planets for every day in the year), or the Nautical Almanac, the observer should place his eye in a line with the balls representing these planets, and mark the phases of Venus as seen from the earth, whether a crescent, a half moon, or a gibbous phase. He should then adjust the equatorial telescope for Venus, if she be within the range of view, and he will see the planet with the same phase in the heavens. This exhibition never fails to gratify and convince the observer. But it can seldom be done if we must wait until the planet be visible to the naked eye and capable of being viewed with a common telescope; for it is sometimes invisible to the naked eye for nearly one-half of its course from one conjunction to another. Besides, the phases of this planet are more distinctly marked in the day time, when it is near the meridian, than either in the morning or evening, when at a low elevation, in which case it appears glaring and undefined on account of the brilliancy of its light, and the undulating vapors near the horizon through which it must then be viewed. With an equatorial telescope of a power of 60 or 80 times, most of the stars of the first magnitude and some of those of the second, can be seen even at noonday. Venus may be seen with this instrument in the day time during the space of 19 months, with the interruption of only about 13 days at the time of her superior conjunction, and 3 days at the time of her inferior; so that the phase she exhibits may be seen almost every clear day.

Admitting then that the earth is of globular form, as doubtless all our readers are now prepared to do, it necessarily follows that it may be inhabited on every side, and consequently that those who live on opposite sides of the globe must have the soles of their feet pointing towards each other, and their heads pointing in opposite directions; and that if by any motive power acting from the earth's interior, they should be carried forward in the directions to which their heads point, and the power to be continued in operation they would never meet during all eternity. This would result from the gradual and equal expansion of the earth on all sides by the operation of some expanding force in the interior, of which supposed circumstances we have spoken before. It also follows that could we suppose a hole bored through the earth's centre, commencing at the

point where we now stand, and extending to the opposite side, it would terminate at our antipodes, and would measure nearly eight thousand miles. It likewise is most evident that this terraqueous globe is either at rest in empty space or is moving round its axis every day, and with immense velocity round the sun every year. If we suppose the earth in a quiescent state in empty space, we have presented to our view a globe containing two hundred and sixty-four millions of cubical miles resting upon nothing, and surrounded with the immense bodies of the universe with no visible support to prevent it from sinking into the depth of infinity. If we suppose it to be revolving round its axis and at the same time round the sun, a globe of the huge dimensions now stated, moving with a velocity of over a thousand miles an hour round its circumference, and of at least sixty-eight thousand miles an hour in its course round the sun, without ever intermitting its speed a single moment, we have presented to us a view sublime and astonishing indeed, but not anything more so than what we see in the case of other heavenly bodies of a thousand times larger dimensions, and a view a great deal more reasonable than that of supposing it at rest in space with all the huge bodies of the universe revolving round it as their centre. It is plain, however, that whichever of these suppositions we hold to be the true one, an astonishing and sublime idea is conveyed to our mind.

Phenomena arising from the Earth's motion.

First: if the earth revolve round the sun once every year, it is evident that the sun will appear to make a revolution round the heavens in the same time. In the figure let S represent the sun in the centre, and A B C D, the earth, in four positions; and let us suppose the earth to move in the order of the letters A B C D; it is evident that when the earth is at A, the sun will appear in that part of the heavens in which the stars at G are situated. When the earth has moved to B, the sun will appear to have moved to the stars opposite to H. And, in like manner, when the earth has moved to C, the sun will appear opposite to E. And when it has moved to D, the sun will appear at F. And when the



earth has moved to A, the sun will again appear at G. And, as the earth revolves round the sun in the orbit A B C D, so the sun will appear to a spectator on the earth, to describe the circle in the heavens, E F G H. Hence it is that we see the sun gradually proceeding in his course round the concave of the sky from west to east, at the rate of nearly one degree every day, through the twelve signs or constellations of the zodiac. And at the end of a year he returns to the same point from which he set out. Hence, also, it follows, that, if the plane of the earth's orbit be conceived to be extended to the heavens, it will cut the starry firmament in that very circle in which a spectator in the sun would see the earth revolve every year, while an inhabitant of the earth observes the sun to go through the same circle in the same space of time. This circle, then, is called the ecliptic, the *apparent* path of the sun, the *real* path of the earth through the heavens. And, although the path of the sun, and the particular stars he is passing along, cannot be seen in the day-time, yet, by observing the stars which are directly opposite to him at night, we can tell at any time what particular stars the sun is passing along at every point of his course.

The inhabitants of all the other planets will perceive different motions in the sun as we observe, but performed in different periods of time, according to the times of their annual revolutions. An inhabitant of the planet Mars, for example, would see the sun apparently revolving round him in the heavens in the space of about one year and ten months. The circle which the sun would appear to him to describe would not be very different from that of the earth, as the inclination of his axis to the plane of his orbit is not very different from that of the earth to the plane of the ecliptic. An inhabitant of the planet Jupiter would see the sun apparently revolving around him describing a circle in the heavens in the space of twelve years. This circle would not be exactly the same as our ecliptic, because the orbit of this planet is somewhat inclined to that of the earth; but it would pass very near it. In the space of one of our years the sun from Jupiter would appear to pass through only a twelfth part of the circumference of the heavens. The sun from Saturn will appear to move in another circle in twenty-nine and a half years; from Uranus, in another circle, in about eighty-four years, from Neptune in one hundred and sixty four and three fourth years; and a spectator in Venus will see the sun moving in a circle different from all these with greater apparent rapidity, in the space of seven and a-half months. All these apparent motions of the sun arise from the real motions of the respective planets. Secondly; the annual motion of the earth shows why we behold one set of stars in our firmament at one season

of the year, and another set of stars at a different season. For example, the stars and constellations which, in our northern latitudes, are seen in the south during the winter months, are altogether different from those which are seen in summer; and those stars which surround the pole in the north, and which never set, if they are below the pole in winter, they will be seen as far above the pole in summer. At the equator, where all the stars north and south rise and set, the stars which are seen in the middle of winter are all completely different from those that are seen at the same hour in the middle of summer. This is easily explainable by the preceding diagram, in which the earth, in four situations in its orbit, appears half enlightened and half in the dark, representing day and night. When it is at A, the sun will appear at noon at G, and obscure all the stars in the hemisphere F G H; when, as at midnight, the point of the heavens E will be in the meridian, and all the stars in the other hemisphere, F E H, will be visible. Three months afterwards when the earth comes to the situation B, the sun at noon will be seen at H, and all the heavens, G H E, will be day, illuminated by the sun; and over all the other half, E F G, the stars will shine at night; consequently, the stars in the quarter F G will now be visible, which, in the former position, were obscured by the sun; and those in the quarter H E, formerly visible will become obscured by daylight. In like manner when the earth is at C, the heavens H E F will be day, and F G H night, when all the stars which were obscured when the earth was at A, will not be visible. And, lastly, when the earth is at D, the stars and constellations in the hemisphere E F G will be obscured by the light of the sun, and those on G H E will be visible during the night. Hence all who are accustomed to observe the heavens will have seen that the bright constellation Orion, the brilliant star Sirius, which follows it, and the Pleiades, or Seven Stars, which are visible in the southern sky during the winter and the approach of spring, are never seen during the summer months, because the sun is then illuminating that portion of the firmament where they are situated; but, being above the horizon in the day-time, they may be seen by means of equatorial telescopes.

By observation of the starry heavens we find that the stars never alter their positions in relation to each other. They appear to move around us in one compact body as the figures of the constellations do on a celestial globe, when that instrument is turned round its axis; but the stars of one constellation never approach or move away from those of another. If, for example, we direct our attention to the stars of the Great Bear in the northern sky we shall find that at all hours of the day and night, and at every season of the year they pre-

sent the same definite figure, and maintain the same relative positions to each other, without any sensible variation of distance or magnitude; and the same may be observed from one year to another. Hence, as before mentioned, they are usually denominated the "Fixed Stars." But when we examine the heavens with more care and minuteness we occasionally perceive a few bodies, having the appearance of stars which when carefully watched for a few weeks or months, are found shifting their positions with relation to the surrounding stars. In most cases their movements are toward the East, but not unfrequently toward the West; and at certain times no motion can be observed for a considerable number of days. The bodies which are thus perceived to change their positions among the stars are called planets, which word, as before mentioned, means "Wandering stars." Until very recently there were only ten bodies of this description known to astronomers, and the paths of these had been traced in the heavens and their motions accurately ascertained. Nearly one hundred of these bodies, all of them of small dimensions, have lately been discovered in the space intervening between Mars and Jupiter. Five of the planets are visible to the naked eye, and these were known to the ancients, who gave them the following names, derived from the heathen mythology: Mercury, Venus, Mars, Jupiter and Saturn; and if we count the Earth in it makes six. By long and careful investigations of the phenomena and motions of these planets, astronomers have ascertained that they all move round the sun, as the centre of their motions; and along with the earth, the minor planets and the moons form one grand and harmonious system with which we are intimately connected, and which is called the solar system.

The following is a list of the principle bodies of this group, in their order in space; First the Sun, the common centre around which the planets all revolve; Vulcan, a planet very recently said to be discovered, but whose existence is as yet by some considered doubtful, Mercury, and Venus; which all are distinguished as the inferior planets, their orbits being included within that of the earth; the Earth, and the superior planets; Mars, the minor planets or asteroids, Jupiter, Saturn, Uranus, and Neptune. There are also many secondary planets or moons, as well as comets, which are reckoned as belonging to this system: besides there may be many other planetary bodies in it; doubtless there are many, that yet remain undiscovered.

As we enquire more particularly into the movements of these bodies we discover many striking points of similarity. They all move round the sun in the same direction, and in elliptical paths of no great eccentricity. They are all opaque bodies, like the earth, shin-

ing only by reflected light; and all rotate on their axes, so as to produce the alternation of day and night. Their orbits, too, are all inclined to the plane of the ecliptic or earth's orbit. The following is a method by which we may obtain a tolerably correct idea of their comparative magnitudes and distances, and the relative dimensions of their orbits. Select a large, clear space, and place nearly in the centre, a ball of about two feet in diameter to represent the sun; Vulcan will then, supposing such a body to be really existing, be represented by a small pin's head 27 feet from the globe; Mercury by a mustard seed 82 feet distant; Venus by a pea at a distance of 142 feet; the earth by a pea of about the same size, or slightly larger, at a distance of 215 feet; Mars by a large pin's head at a distance of 327 feet: the minor planets or Asteroids by very small grains of sand between 500 and 600 feet distant; an orange of about $2\frac{1}{2}$ inches diameter, and 1120 feet distant, will represent Jupiter; one about 2 inches in diameter and distant two-fifths of a mile will stand for Saturn; a full-sized cherry, three quarters of a mile distant, Uranus; and a plum, a mile and a quarter off, for Neptune. On this scale the distance of the nearest fixed star is reckoned at 7,500 miles.

THE SUN.

As the sun is by far the largest of these bodies we shall treat of him first; and the question which at once suggests itself is, what is the distance of this body? The accurate solution of this question is found to be one of the most important problems in astronomy, as this distance is taken as the measure for determining the distances and magnitudes of the other heavenly bodies. There has always been great difficulty experienced in determining the distance of the sun, owing to the fact that the earth's diameter, being so small compared with the sun's distance, did not afford a base line of sufficient length for a triangle by which the sun's parallax, and thence his distance, might be obtained. There has however, been obtained what is considered as a near approximation to it, by means of observations taken of the transits of Venus. As a result of these observations the sun's mean distance is determined to be about 91,430,000 miles. Until recently the sun's distance has been taken at 95,000,000 miles; but subsequent investigations have shown an error in these measurements. The numbers here given, however, are only given as approximations subject to future correction. The next transit of Venus, is anxiously awaited to settle the question decisively. It may be remembered, too, that the distance given above is the *mean*, the difference between the minimum and

maximum being about 3,000,000 miles. Having ascertained the distance of the sun, and knowing its apparent diameter to be about $32'$, a little over half a degree, we obtain his real magnitude by a simple proportion; and in this way we find his diameter to be, in miles, about 853,000, or more than one hundred and eight times that of the earth. The sun's volume is so great that it would require over 1,300,000 globes of the size of the earth to be rolled into one to equal it; and it is computed to be 450 times as large as all the known planets which revolve around it taken together. Its surface contains more than 12,000 times the number of square miles on our globe. The reason why the sun appears so small to our eyes, although being a globe of such immense magnitude, is owing to its great distance from our world. This distance may be illustrated somewhat as follows: It would require a cannon ball, though flying continually with a velocity of 500 miles an hour, 21 years before it could reach the sun. Suppose a steam carriage to set out from the earth in the direction of the sun, and to move without intermission at the rate of twenty miles an hour, it would require over 520 years before it had traversed the whole space which intervenes between us and that luminary. How wonderful then that the sun at such a distance should exert his attractive power upon the earth, raise the tides in the oceans, and diffuse light, heat, color, and animation over all its regions! Some idea can be formed of its light and heat when we remember the enormous distance at which we are from its surface, and the degree, notwithstanding this, to which we feel its power and influence. Its light is computed to be equal to that of 5,500 standard candles placed at a distance of a foot from the given surface to be illuminated. We naturally want to know something more about the physical properties of this wonderful and stupendous orb; but we are to a great extent baffled in this enquiry, just as we are in regard to the exact physical properties of the bodies which make up the earth's interior; though many great and important discoveries have been recently made by means of spectrum analysis. In this way it has been ascertained that many of the metals present in the earth are also present in the sun.

When pieces of very dark glass are placed in front of the eye-piece of a telescope, so as to screen the eye from the intense glare of the sun, its surface may be carefully examined, and it is found to present an appearance by no means uniform. Many dark spots termed *maculæ* are found at times to exist on its surface. See figures 102 and 103. The centre of these is usually of a very dark color, and is surrounded by a margin much lighter in appearance which is known as the *penumbra*. These spots are very irregular in shape, and frequently

change in size or disappear altogether. This may in the main be accounted for by the rotation of the sun on his axis, by which different portions of his surface are presented to the earth in succession. The spots appear first on his eastern margin, at which time they appear narrow and somewhat obscure; they move gradually onward to the



Fig. 102.

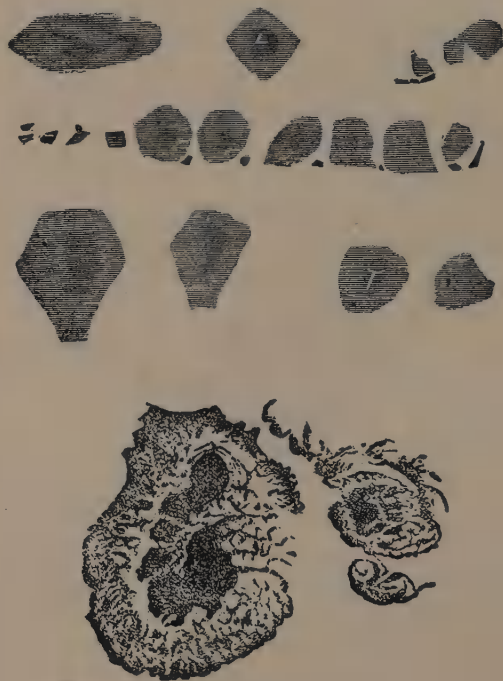


Fig. 103.

centre of the disc, when they appear larger and more distinct; afterwards they proceed toward the western margin, where they again appear narrow and obscure; and after a period of about 13 days from their first appearance on the eastern edge, they disappear from the western limb; and, in many cases, they again appear on the eastern limb, after the same period of 13 days. But they are frequently somewhat changed in their aspect before they reappear; and in numerous instances, after disappearing from the sun's western boundary, they are never again visible in the same shape; but other spots at uncertain intervals, are seen diversifying the solar disc; though not unfrequently scarcely a single spot is to be seen on the whole surface of the sun. The spots appearing narrower and less distinct on the eastern and western limbs, is owing to our viewing obliquely those parts of the sun's surface. The conclusions which may be deduced from these circumstances are: 1st. That the sun is a globe and not a flat surface, as it appears to the naked eye; otherwise the spots would appear equally large and distinct on every part of its surface: 2nd. That this luminary moves round his axis in the same direction as the rotation of the planets; for its spots do not alter their places on its disc, but are carried along with the whole body of the sun. The time of the apparent revolution of these spots is 27 days, 8 hours; but the real period of the sun's rotation on its axis is 25 days, 7 hours, and 48 minutes; and therefore, the spaces about the sun's equator move at the rate of 4,407 miles an hour.*

The solar spots are of different sizes, and of different shapes. Their dimensions vary from the $\frac{1}{800}$ th to the $\frac{1}{30}$ th of the sun's diameter. The smallest of these spots which can be distinctly seen are nearly 1000 miles in diameter. Spots the $\frac{1}{50}$ th part of the sun's diameter, which are frequently seen, are 17,600 miles in diameter, or more than double the diameter of the earth; and if the spot be considered only as a plane, and somewhat circular, it will contain a considerably greater area than the whole terraqueous globe, and sometimes a spot of this vast size disappears in a few weeks not unfrequently in a few days. Sometimes no spot is to be seen on the solar disc for weeks and even for months together; at other times, over a hundred spots of different sizes are dispersed over its surface at one time. In such cases, there are generally five or six large spots such as that alluded to above, accompanied with ten, fifteen, or twenty smaller spots; but after disappearing at the sun's western limb, it is seldom they come round again in the same order as before. Some appear to have been

* This is obtained by dividing the sun's circumference 2,679,785 miles by the number of hours in which the rotation is performed, namely 608; and the quotient is the rate of motion per hour.

altogether dissipated, and others to have changed their shape and relative positions to surrounding spots in which they formerly appeared. Some of these spots of considerably larger dimensions than the earth, containing three or four hundred millions of square miles, occasionally appear and vanish in the space of 48 hours. The parts of the sun's surface where these spots most frequently appear, are those which lie adjacent to its equatorial regions; no spots being ever seen near its northern or southern poles. In some years these spots appear in great numbers, and seldom a week passes without a few of them being seen while in other years comparatively few are visible. Careful records have been kept of their appearance.

They are found to diminish in frequency for about five or five and a half years, when the number is at a minimum, the surface being then free from them on more than half of the days of observation. They then increase again in number for the next five and a half years; and thus their period appears to be about eleven years. A remarkable fact has been noted in connection with this, and that is that the daily variation of the magnetic needle is found to have a precisely similar period, and to increase or diminish with the increase or diminution of the number of spots. Other phenomena seem further to show that there is an intimate relationship existing between the movements of the magnetic needle and the sun. Further observations will doubtless reveal to us more of this natural bond, and new discoveries on the subject are frequently being made.

Besides the dark spots, which we have now described, there are spots which display a bright and mottled appearance, and which it is difficult in most cases to distinguish from the real body of the sun. These are termed *faculae*. They are chiefly to be seen when they first appear on the eastern margin of the sun, and when they approach near the western limb; but they are rarely seen near the middle of the disc. They are most generally seen in connection with clusters of dark spots, and when they are first seen near the eastern limb they frequently indicate that dark spots are about to appear. They appear like luminous mountain ranges, plainly indicating that the sun is not a smooth surface, but is diversified with elevations and depressions, or in other words, with mountains and vales of stupendous dimensions; otherwise we could by no means perceive them at the immense distance at which they are placed from us.

Recent telescopic investigations, however, show that, beside the markings of which we have spoken, the whole surface of the sun has somewhat a mottled appearance. According to Nasmyth it presents an appearance as if it were covered over with scattered filaments, shaped like willow leaves. The whole question of the physical con-

stitution of the sun is now engaging the attention of many astronomers. A total eclipse of that body presents a good opportunity for the observation of many points, and among the most remarkable features in connection with these phenomena is the presence of dark flames or protuberances surrounding the dark body of the moon at the moment of total obscuration. These have recently been seen at other times also, and are believed by some to be connected with the solar atmosphere. They probably arise from certain portions of the sun being for the present more combustible, and in a state of more intense incandescence than others.

The question will naturally suggest itself—if the sun is continually in a state of combustion, will it not at some time be consumed? A knowledge of chemistry will go far toward answering such a question as this. Bodies while undergoing combustion are also undergoing chemical decomposition, or a separation of their component parts into their primary elements, but not a single particle of them is

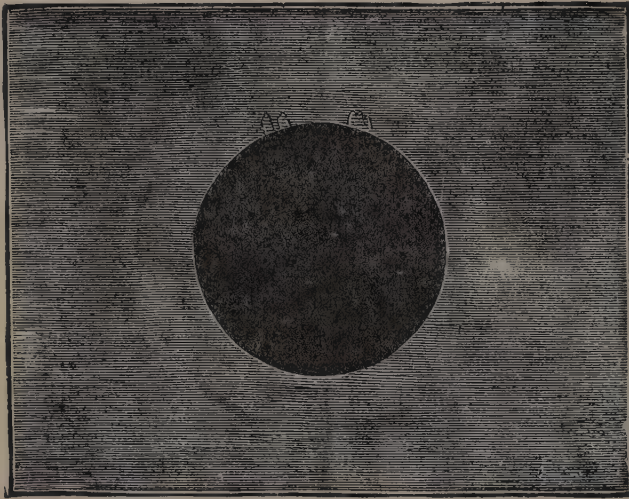


Fig. 104. ECLIPSE OF THE SUN, JULY 18, 1860.

lost by the process. Light is only a manifestation which attends combustion, and is equally attendant upon the combination as upon the separation of chemical elements; the matter of the body undergoing combustion, unless what residuum there may be from it, is resolved into gaseous elements which ascend to the level of their gravitation in their atmosphere, and there float, until, perhaps, recombining with other chemical elements for which they have an affinity, they thus return to the surface of their sphere again, it may be—as in the case of the earth's atmosphere they do—in the form of a meteor, but in some way or other they eventually return to the surface

of their spheres, not a particle of them being lost by the manifestation of light. By this it is understood that the elements of the sun in connection with which light is manifested, may go on separating and recombining under the influence of combustion* without any actual waste or exhaustion of matter, as long as the want of equilibrium between his elements makes combustion to be a consequence of their contact. The constitution of the sun appears to be of such a nature, and such is the purpose which it answers in the system, that it may have ever existed and may ever exist luminous. Albeit, what hinders that during certain periods of the past our system may not have been enlightened by some other luminous body?

According to Sir Wm. Herschell's estimate the atmosphere of the sun is not less than 1840 and not more than 2760 miles in depth. This he regards as the outermost coating of the sun, or his visible surface; and under this superior stratum he conceived there is another, more dense and highly reflective, which throws back the light of the upper regions, and that this lower atmosphere constitutes the umbra of the spots, and that the dark central parts of the spots or the nuclei, are part of the solid matter of which the sun's body is composed. According to such views the globe of the sun may be regarded as of considerable density, not altogether unlike the earth and the other planets, and not a very great portion of its surface, comparatively speaking, as being in a state of combustion; and there is no improbability in supposing it to be inhabited with sensitive and intelligent beings having constitutions adapted for their situation; and it may constitute the most glorious habitation connected with the solar system. It is evident, however, whatever may be the real nature and constitution of this luminary, from the rapid and extensive changes which are seen to take place in connection with the spots on his surface that there are forces of prodigious power in continual operation there, producing the most astonishing effects in short spaces of time. And such changes are doubtless necessary for preserving the present state of the sun, for enabling him to diffuse light and heat, and to act as the soul of surrounding worlds. This magnificent luminary is the great source of light and heat and color to our world; and to all the planetary globes, with their satellites and rings, which belong to our system. By its influence it cheers, animates, and adorns a retinue of worlds; by its attractive energy it directs their motions, and confines them all to their proper paths, so that none can wander

* There are, however, some who do not consider the sun's light to arise from combustion. Among these were Sir Wm. Herschell and Humboldt who supposed the sun's outer atmosphere to be in a state of permanent luminosity, by means of electric or magnetic agency, that is to say, the sun's light would be somewhat after the nature of a continual "Northern Light."

from their course or interfere with the others. Without the influence of this luminary darkness and all its gloomy accompaniments would involve our world; the beauties which adorn the face of nature would nowhere be seen; the warbling of the birds would not be

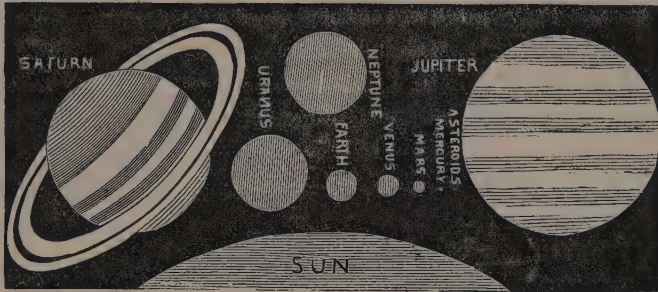


Fig. 105-

heard; the flowers would not be decked in their gay colors, nor shed their rich perfumes; our earth would be a hideous chaos. Can we reflect therefore upon the grandeur and magnitude of this luminary, and the manifold beneficial effects which it produces in our world, without raising our thoughts to Him who appoints it for this purpose! In all our surveys and contemplations of nature it becomes us to raise our thoughts from the effect to the cause, from the creature to the Creator,—for God is the Creator of the solar light, as of all other creatures,—and to give Him the glory due to His name.

THE PLANET VULCAN.

We now pass on to notice the planets which revolve in ceaseless courses round the sun. About fourteen years ago Le Verrier, a French astronomer, having very carefully examined the movements of the planet Mercury, found in it a slight variation which he could account for only by supposing that the mass of the planet Venus was incorrectly ascertained, or else that there was a planet revolving round the sun in an orbit within that of Mercury. He published some statements to this effect in the hope that some further light might be thrown on the matter. It must be remembered, however, that Mercury itself, which until now was considered the nearest planet to the sun, can only be seen at occasional intervals, and then with difficulty, on account of its apparent proximity to the sun; and that, therefore, a planet much nearer to the sun would never appear far enough removed from that body to be clearly discerned. Almost the only opportunity of observing it then would be when it should be in transit. As soon as Le Verrier had published his statement a French physician, named Lescarbault, announced that on the 26th of March, 1859, he had seen a small body pass across the sun, but had not liked to announce the fact before, no other observer having called attention to it. Le

Verrier at once saw him and carefully enquired into the matter. At first he thought the whole affair was a delusion; but after questioning the physician, and enquiring as to the apparatus he had used, he became convinced that he had indeed discovered a new planet, which was then called Vulcan. From this one observation no very decisive details could be drawn so as to calculate its orbit accurately; its distance from the sun was, however, set down at about 14,000,000 miles, and its time of revolution in its orbit at a period of a little under twenty days. It was conjectured that a second transit might be observed in March, 1860; but though a careful watch was kept it was not seen; nor has it, that we have learned, been seen again up to the present time, excepting that was it which was observed by Mr. Lummis of Manchester, England, on March 20th, 1862, when he saw a black spot pass across the sun's disc, and conjectured it might be a planet in transit. Instances have also been previously recorded of spots resembling planets being seen on the sun; and future observations will perhaps show, that the planet really exists, as well as some others, in that luminous space, and that these have been transits. Astronomers, however, do not pronounce definitely either way as to the alleged planet, and are only awaiting the results of future investigations concerning it.

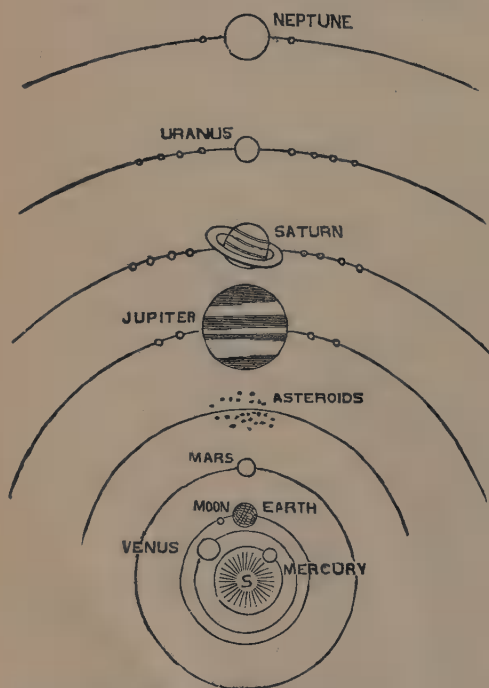


Diagram illustrating the relative positions, etc., of the sun, planets, and planetoids.

THE PLANET MERCURY.

This planet has been known from the earliest ages of astronomy of which we have any records. This speaks well for the research of the early astronomers; for, owing to its small size, and its proximity to the sun, it is very difficult to obtain a satisfactory view of this planet. It is said that the celebrated Copernicus, although the greatest part of his life was devoted to the study of the heavens, never once succeeded in obtaining a view of this orb. The greatest distance at which it can ever be from the sun is 29° , and sometimes its elongation, before it begins to return, is,

not more than $16\frac{1}{2}^{\circ}$. The mean distance of Mercury from the sun is nearly 35,390,000 miles. Its eccentricity, that is, the distance from the centre of its orbit to the centre of the sun, being very great (about seven millions of miles), its distance varies between 28,000,000 and 43,000,000 miles. It performs its journey round the sun in a trifle over 87 days, so that its year is less than a fourth the length of ours. Its speed in its orbit is far greater than that of any of the other known planets; being computed to be at an average 109,800 miles an hour, or 1,830 miles a minute; hence in the ancient mythology Mercury was represented with wings to his feet; and his mane is said to signify "the swift messenger." This planet is but small, its diameter being reckoned at 2,960 miles, or rather more than one-third that of the earth. Hence its circumference, or a line extending quite round it, would measure about 9,299 miles; and the number of square miles on its surface would be nearly 27,525,040. Its period of rotation round its axis is 24 hours $5\frac{1}{2}$ minutes, and thus it clearly resembles the earth as to the length of its day. A transit of this planet occurs whenever it is in one of the nodes (that is, at the point where its orbit intersects that of the earth), at the time of an inferior conjunction. The next time this will occur will be on the 6th of May, 1878. If the orbit of this planet were in the same plane with that of the earth it would transit the sun's disc at every inferior conjunction, or three or four times every year. But as its orbit is inclined to the ecliptic a transit can happen only when it comes to the inferior conjunction at the time when it is at or near its nodes, and when the earth is in the same longitude; and this occurs only at intervals of several years. This planet exhibits phases corresponding to those of the moon. On account of its proximity to the sun few discoveries have been made on its surface by the telescope. It has been observed, however, that when it appears as a crescent one of its horns is truncated, or cut off at the point, by which the period of the planet's rotation round its axis has been determined. This truncature is doubtless the effect of elevations and depressions on its surface; and hence some astronomers have concluded that mountains of considerable height exist on Mercury, one of which is estimated to be 8 miles in perpendicular altitude. The quantity of light received on Mercury is nearly seven times that which we receive; and the sun will appear from Mercury seven times the size he does to us. This planet is supposed also to be enveloped with an extremely dense atmosphere.

Though diminutive in its appearance, and seldom seen by the inhabitants of the earth, we can scarcely doubt that there exist on Mercury millions of sentient and intelligent creatures, perhaps

superior in scale of being to man, with constitutions fitted for that sphere in which they are, and with mental powers which qualify them to know, to love, and to adore their great Creator.

Appearance of the Heavens as Viewed from Mercury.

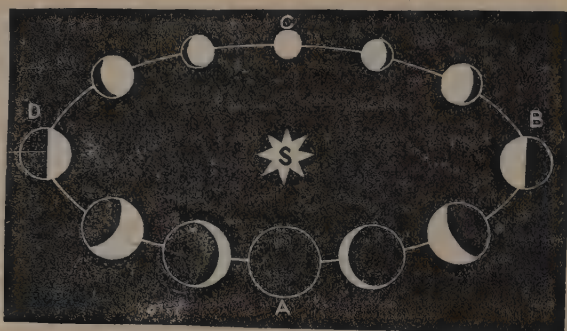
The situation of this planet being so near the sun has prevented us from discovering various particulars which have been discovered in relation to several of the other planets; and therefore not much can be said with respect to the scenery of its firmament. The starry heavens will appear to move around it every 24 hours, as they do to us; but as the direction of its axis of rotation is not known we cannot tell what stars will appear near its equator or its poles. The sun will present a surface in the heavens seven times as large as he does to us, and of course will present a very grand and splendid appearance in the sky, and will produce a corresponding brightness and vividness of color on the objects which are distributed over the surface of the planet. Both Venus and the Earth will appear as superior planets; and when Venus is near its opposition to the sun, at which time it will rise when the sun sets, it will present a very brilliant appearance to the inhabitants of Mercury, and serve the purpose of a small moon to illuminate the evenings in the absence of the sun. As Venus presents a full enlightened hemisphere at this time to the inhabitants of Mercury, it will exhibit a surface six or seven times larger than it does to us when it shines with its greatest brilliancy, and, therefore, will appear a very bright and conspicuous object in the firmament of this planet. At all other times it will appear at least two or three times larger than it ever does to us. It will generally appear round; but at certain times it will exhibit a gibbous phase, as the planet Mars frequently does as seen from the earth. It will never appear to the inhabitants of Mercury in the form of a crescent or half moon, as it sometimes does through our telescopes. There is no celestial body within the range of this planet, of which we have any definite knowledge, which will exhibit either a half moon or a crescent phase, unless it be the supposed planet Vulcan, and unless the planet itself be accompanied with a satellite. The earth is another object in the sky of Mercury which appears next in splendor to Venus. The earth and Venus are nearly of an equal size; but the earth being nearly double the distance of Venus from Mercury its apparent size at the time of its opposition to the sun is only about half that of Venus. The earth, however, at this period will appear in the firmament of Mercury of a size and splendor three or four times greater than Venus does to us at the time of its great-

est brilliancy. Our moon may also be seen, like a small star, accompanying the earth, sometimes approaching to or sometimes receding farther from the earth, and sometimes hidden from the view by passing across the disc of the earth, or through its shadow. It will probably appear about of the size and brightness of Mars, as seen from the earth. The earth, with its satellite, and Venus will be seen near the same point of the heavens at the end of every nineteen months, when they will appear for some time the most conspicuous objects in the sky, and diffuse a considerable portion of light in the absence of the sun. At other periods the one rises in the eastern horizon as the other sets in the western; so that the inhabitants of Mercury are seldom without a conspicuous object in their nocturnal firmament, diffusing an illumination far superior to that of any other stars or planets. The earth is in opposition to the sun every four months, and Venus after a period of five months. The planets Mars, Jupiter, and Saturn will appear with a somewhat inferior degree of magnitude and brilliancy than they do to us, particularly in the case of Mars. The period of the annual revolution of Mercury being 88 days, the sun will appear to move from west to east through the circle of the heavens at a rate more than four times as great as his apparent motion through the signs of our zodiac.

THE PLANET VENUS.

This planet is the next in order from the sun. It has been known from remote antiquity as the morning and the evening star, because in one part of its course it makes its appearance in the West in the evening before any other star is visible, and in another part of its course it appears in the East in the morning, ushering in the dawn, and giving notice of the approach of the rising sun. So brightly indeed does it shine that it is visible at times to the naked eye during the day, and casts a shadow at night. But its apparent size and brilliancy vary very greatly, as will be easily understood if we remember that when in its inferior conjunction it is within twenty-five millions of miles of the earth; while when it is in superior conjunction this distance is increased by the diameter of the orbit of Venus, and becomes nearly one hundred and sixty millions of miles. The quantity of light which this planet receives from the sun is nearly double that which falls upon the earth, owing to its greater nearness to the source of light; so that the sun will appear from its surface twice as large as it does to us. When in the part of its orbit directly between the earth and sun, that is, in inferior conjunction, it is at its least distance from us, and hence would appear most brilliant if

it were luminous. If indeed at this point its enlightened side were turned toward the earth it would present a surface twenty-five times larger than it generally does, and shine with the splendor of a small



moon; but as its dark side is now turned toward the earth it is invisible just as the moon before new moon. Besides this, it appears so close to the sun as to be lost in his brightness, unless it should happen to pass across the sun's disc, where it appears as a round black spot. This will be seen as at A in the figure where S in the centre represents the sun, and the earth is conceived to be in a line with the sun and Venus on the dark side of the latter. As the planet now travels onwards towards B it gets further and further removed to the West of the sun, and thus rises earlier and earlier, being then known as Lucifer or the morning star. At the same time its bright hemisphere becomes partly turned toward the earth. When exactly half enlightened, as at B, it is at its greatest elongation from the sun, being distant about 48° . Its period of greatest brilliancy is, however, a little before this when about one-third of its disc is illuminated. Having attained its greatest elongation, it seems stationary for a short time and then appears to return toward the sun, an increasing portion of the disc being illuminated, though, on account of its increasing distance, it appears smaller. It is then lost again in the sun's rays for a time, and when it reappears to the East of the sun, it does not rise till after that luminary, and, therefore, is no longer the morning star. At this time, however, it remains visible for some time after sunset, and is known as Hesperus, or the evening star. After attaining its greatest eastern elongation at D it returns to A to go through the same phases again. While travelling about half the distance between D and A, or that half next to D, it appears stationary, in the other half, or that nearest to A, it appears to retrograde; and so while travelling half the distance from A to B, or that half nearest A, it appears still to retrograde, while in the other half, or that nearest to B, it appears stationary. These phases

are not visible to the naked eye, and hence the absence of them was adduced as an argument against the truth of the Copernican system. This was before the invention of the telescope. Galileo, however, in 1610, on turning his newly-constructed telescope to the planet, at once discovered the fact of their existence. This is one of the strongest arguments adduced in proof of the system which has the sun as the centre of the planets' motions. The period which elapses between one inferior conjunction and another, or that is occupied in going through this cycle of changes is 584 days, and this is called its *synodic* period. The time, however, that is occupied in completing a circuit round the sun is only 224 days and 17 hours. At first sight these results appear inconsistent, but the apparent discrepancy vanishes when we recollect that the earth is itself in rapid motion, so that by the time Venus has completed a revolution round the sun, the earth has travelled round a large portion of its orbit, and Venus has to overtake it before another conjunction can take place.

The distance of Venus from the Sun is about 66,130,000 miles; and its orbit is nearly circular, its eccentricity being less than half a million of miles, or about the 1-276th part of its diameter, so that its distance varies but slightly. When viewed through a good telescope this planet is a very beautiful object, especially when near its inferior conjunction, so as to appear in the form of a crescent; but the brilliancy with which it shines is so great that no distinct markings can be made out on its surface. The inner edge is, however, considerably indented, indicating the presence of inequalities on its surface; from this some observers have calculated that the height of its mountains is much greater than that of any on the earth. The height of such elevations is ascertained from the length of their shadows. M. Schroter, a celebrated German astronomer, estimated the perpendicular height of one of these mountains to be ten and a half English miles, and that of another no less than nineteen miles. Although these elevations so far surpass the highest mountains on our globe, yet, on this account, such estimates should not be considered as improbable. For, in nature, there is an endless variety, and our observations on the moon and nearest planets show us that every planet differs from another in the peculiar features of its surface. Such lofty elevations must add to the sublimity of nature on the surface of Venus, and will afford, from their summits, prospects far more extensive than we can now conceive. M. Schroter also deduced from several observations that Venus has an atmosphere of considerable extent, the densest part of which is above three miles high. A similar conclusion was deduced by a number of observers in different places, when viewing the transit of this planet in 1761. At the time when the planet

entered on the sun's disc, and when it was about to emerge from the eastern limb, a faint penumbra, or dusky shade, was seen surrounding the planet, which indicated an atmosphere of considerable height. The period of the rotation of this planet on its axis is not very different from that of the earth, being twenty-three hours twenty-one and a-half minutes; its day is, therefore, but thirty-five minutes shorter than ours. Its axis has an inclination of $73\frac{1}{2}^{\circ}$. Its diameter also closely approaches in dimension that of the earth, being 7,510 miles; so that the planet which is nearest to us is found in many important respects to resemble the earth very closely; and analogy leads us to infer that in many other respects it may be a counterpart. Its circumference, or a line extending quite round it, measures 23,593 miles, and the number of square miles on its surface is 177,183,430. Several observers assert that they have seen a satellite accompanying Venus. Observations of some able astronomers, who have given some attention to it, have as yet failed to corroborate these statements. The testimony of Mr. Montaigne, however, who observed it on several successive occasions, we consider to be conclusive evidence as to its existence.* But it is evident this satellite would be difficult

* Numbers 3, 4, 7, 11, in figure 107, mark the situations of the satellite, as seen by Mr. Montaigne, on May 3rd, 4th, 7th and 11th, 1760. On May 3rd, he perceived, at 20' distance from Venus, a small crescent, with the horns pointing the same way as those of Venus. Its diameter was one-fourth that of its primary; and a line drawn from Venus to the Satellite, made below Venus, an angle with the vertical of about 20° toward the south, as seen in the figure, where Z N represents the vertical, and E C a parallel to the ecliptic, making then an angle with the vertical of 45° . On May 4th, at the same hour, he saw the same star, distant from Venus about one minute more than before, and making an angle with the vertical of 10° below, but on the north side, so that the satellite appeared to have described an arc of about 30° , whereof Venus was the centre, and the radius 20° . The two following nights being hazy, Venus could not be seen. But on May 7th, at the same hour as on the preceding days, he saw the satellite again but above Venus, and on the north side, as represented at 7, between $25'$ and $26'$ upon a line which made an angle of 45° , with the vertical toward the right hand. On May the 11th, at nine o'clock, p.m., the only night when the view of the planet was not obscured by moonlight, twilight or clouds, the satellite appeared nearly at the same distance from Venus as before, making with the vertical an angle of 45° toward the south, and above its primary. The light of the satellite was always very weak; but it had always the same phase with its primary, whether viewed with it in the field of the telescope or alone by itself. He imagined that the reason why the satellite has been looked for so often without success might be, that one part of its globe was crusted over with spots, or otherwise unfit to reflect the rays of the sun with any degree of brilliancy, as is supposed to be the case with the fifth satellite of Saturn.



to detect, its diameter being so small as only one-fourth that of its primary. It could not be seen at superior conjunction of the planet, for then it would be overpowered by the light of the sun; nor would it be easily seen in any other part of the orbit, its enlightened part being so extremely small. The best time to see it would be at the time of the planet's greatest elongation, when it would appear about half enlightened. Observers should not despair of finding it, for the satellite exists, awaiting their discovery.

The last transits of Venus happened in 1769, when the British Government sent out an expedition for the purpose of making observations; and on December 9th, 1874, when not only the British, but the United States, and other governments, sent out expeditions to different parts of the earth for the same purpose. The next transit will take place in 1882; and none will occur after that till June 8th, 2004.

This planet is doubtless well replenished with inhabitants, and may far surpass the world in which we dwell, not only in point of population, but in sublimity of scenery. Its superficial area is nearly that of our globe; and it does not appear as if a very large portion of it is covered with water; otherwise it would not shine with such uniform brilliancy; the water not being as good a reflector as the solid, rough surface of the land. This beautiful planet, distinguished above all others by its great brilliancy, is occasionally alluded to by the writers of the Scriptures as "the son of the morning," "the day star," and "the bright and morning star," emblematic of the enlightening and cheering effect of truth and godliness upon the minds and hearts of sinful men when the "day star" from on high hath risen in their hearts. When contemplating the bright luminaries of the sky, and especially the morning star, the placid influence they diffuse and the harmony with which all their movements are conducted, we can scarcely refrain from contrasting those scenes with the darkness and disorder which prevail in the moral world. While the sun diffuses his light by day, and the moon and the stars shed their mild radiance by night, it is still necessary to the well-being and happiness of mankind that intellectual light and sacred joy should be diffused in their minds and hearts, of which the light of these luminaries has often served as an emblem. When the morning star makes its appearance near the eastern horizon, it is a sign that the sun will ere long arise, and that the darkness of night will soon be dispelled. When the day star arises in the benighted mind, it intimates that now the light of Divine truth has begun to irradiate it, and to dispel the darkness, with all its miserable accompaniments, which formerly reigned in it; it is a sign that this light will still increase and shine more and more unto the perfect day.

Celestial Phenomena, as Viewed from Venus.

To the inhabitants of this planet the firmament will present an aspect nearly similar to that of Mercury, with a few variations. Mercury is to Venus an inferior planet, which never appears beyond 34° from the sun. It will appear in the evening after sunset for the space of two or three hours when near its elongation, and in the morning before sunrise, when in the opposite part of its course; and will be alternately a morning and an evening star to Venus, as that planet is to us, but with a less degree of splendor. The most splendid object in the nocturnal sky of Venus is the earth, when in opposition to the sun, when it appears with a magnitude and splendor five or six times greater than either Jupiter or Venus appears to us at the time of their greatest brilliancy. It will serve, in a great measure, the purpose of a moon to Venus, if this planet have no satellite; and will cause the several objects on its surface to project distinct and well defined shadows, as our moon does when she appears a crescent. Our moon, in her revolutions round the earth, appears also a prominent object in the heavens of Venus, and probably appears about the same size that Jupiter does to us. Her occultations, eclipses, and transits across the earth's disc will be distinctly visible. With telescopes such as the best we possess, the earth would appear from Venus a much larger and more variegated object than any of the planets do to us when viewed with high magnifying powers. The forms of our different continents, seas, and islands; the different strata of clouds in our atmosphere, with their several changes and motions, and the earth's diurnal rotation, would in all probability be distinctly perceived. Even the varieties which characterize the surface of our moon would be visible with telescopes of a high magnifying power. The circumstances now mentioned prove the connections of the different parts of the planetary system with one another; and that the parts of it are so arranged that one world is, in a certain degree, subservient to the benefit of another. Thus the earth serves as a large and splendid moon to the lunar inhabitants; it serves in a certain degree, the purpose of a small moon to Mercury; it serves the purpose of a larger moon, by exhibiting a surface and a radiance four times greater, to the inhabitants of Venus; and it serves as a morning and an evening star to the planet Mars; so that while we experience enjoyment in contemplating the moon walking in brightness, and hail with pleasure the morning star as the harbinger of day, and feel a delight in surveying those nocturnal luminaries through our telescopes, the globe on which we dwell affords similar enjoyments to the intellectual beings in neighboring worlds, who behold

our habitation from afar as a bright speck upon their firmament, diffusing amid the shades of night a mild and placid radiance. From Venus the planets Jupiter and Saturn will appear nearly as they do to us ; but the planet Mars will appear considerably smaller. The sun to this planet will appear twice as large as he does in our sky, and will appear to make a revolution round the celestial sphere in the course of seven and a half months, which completes the year of Venus.

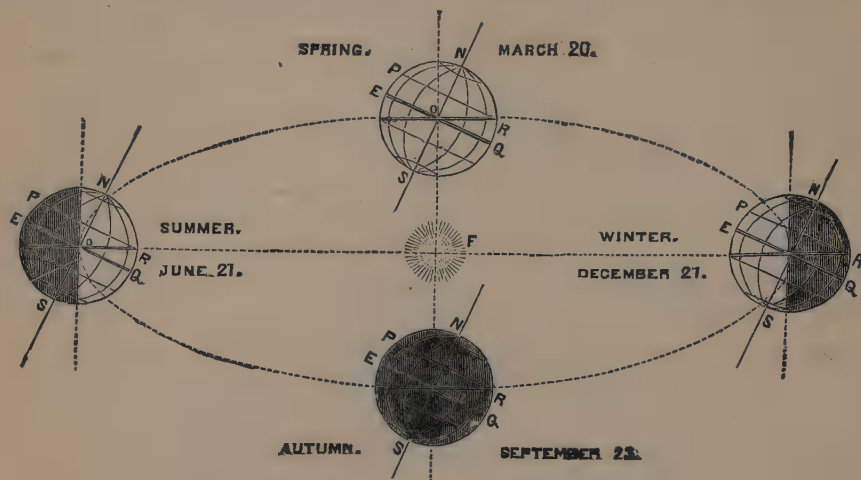
THE EARTH.

The next planet in order is the Earth, which we have hitherto considered as the base from which we made all our observations. It may still seem strange to some of our readers that this world on which we live should be considered a planetary orb ; as at first view it does not appear to bear any resemblance to any of the luminaries that appear in our sky. The planets, as they are seen in the heavens by the naked eye, appear as only comparatively small points of light, whereas the earth, from whatever point we view it, appears the largest body our eyes anywhere behold and when we traverse its surface either by sea or land there appear no boundaries to its dimensions. We have explained before that the nearer a body is to the eye the larger it appears, for the larger the angle is which its extremities subtend in the eye ; and on the other hand the farther removed a body is, the smaller it appears, for the smaller the angle it subtends in our eye. This is the reason why the planets, some of which are much larger than the earth, appear but as visible points in our sky ; and why the moon, though sixty millions of times smaller than the sun, appears equal in bulk to that luminary. From the positions in which we can view any portion of the earth, even when we ascend several miles above its surface in balloons, it does not exhibit a luminous aspect, such as that which the celestial bodies present ; so that at first view we might be inclined to suppose that no similarity exists between our sublunary world and the orbs of heaven. Besides, the celestial prbs are apparently in rapid motion from one region to another, while the earth appears to be at rest in the centre of their motions. There is not, perhaps, one out of a thousand of the earth's present inhabitants who has the least conception that beside every other motion of which he is susceptible, he is carried along through the regions of space with the rapidity of thousands of miles every hour. Yet this is a fact which appears not merely probable but certain, and can be demonstrated to the conviction of every one who is both willing and qualified to enter into such investigations.

Could we stand on the surface of the moon we should behold the earth like a great globe in the firmament, appearing with a surface about 13 times larger than the moon does to us, and presenting its different sides to our view. Sometimes America, and the Pacific Ocean; and at other times, Asia, Africa, Europe, and the Atlantic Ocean; sometimes appearing like a large crescent, or half moon, and at other times with a full enlightened hemisphere. Could we take our station on the surface of Venus we should behold the globe on which we live appearing in the azure sky like a large bright star; and the moon, which appears so large in our firmament, would be seen only like a very small star very near the earth and constantly moving around it. The earth would in general appear about of the same size that Venus does to us, but perhaps not quite so brilliant, owing to three-fourths of its surface being covered with water; at certain times, however, it would appear ten times larger than Venus does to us and like a small brilliant moon. (On the other hand, if the bright side of Venus were turned toward us at the time of her inferior conjunction, that planet would appear about 25 times as large as it usually does.) Were our situation on the planet Mars, which is much farther from the sun than Venus, the earth would appear alternately as a morning and evening star, exhibiting different phases, as Venus does to us, but with a less degree of size and splendor. It might not, perhaps, shine with so much brilliancy as Venus, but it would probably appear of a lustre similar to that which Mars presents to us, or somewhat brighter. It need not be wondered at that the earth would appear as a luminous body from such distant positions; for we have demonstrative proof that Venus, Mars, and all the other planets, though they appear like shining orbs, are in reality dark bodies like the earth, and receive their light from the sun, the reflection of which from their surfaces makes them appear luminous to us; and it is only when the portions of their sides which are enlightened by the sun are turned toward us, that we see them in the heavens. On some occasions the dark side of Venus is completely turned toward the earth, and then she is invisible; and sometimes in this position is seen to pass, as a dark spot, across the disc of the sun. These and many other circumstances demonstrate that the planets are in themselves dark bodies, and shine only by reflection: and consequently that the earth, though a dark body, will appear luminous at a distance by reflecting the solar rays which fall upon it as the moon does to us. We have already proved that as a planet the earth turns round its axis every 24 hours, and also moves round the sun every year; this latter part of our position we will endeavor in the sequel to illustrate by a figure.

The earth's mean radius is $3,956\frac{1}{2}$ English miles; its mean diameter being 7,913 miles; consequently its circumference, or a line extending quite round it, measures 24,859 miles; and the number of square miles on its surface is nearly 196,709,267. Of this it is estimated that 149,000,000 square miles are occupied by the seas and oceans; thus leaving 47,000,000 square miles of dry land, or less than one-third of that occupied by the water. The mean diameter of the earth's orbit is about 182,862,000 miles, and its approximate circumference about 574,709,000 miles. The linear eccentricity of the earth's orbit, being about one-sixtieth of its semi-axis major, or mean distance of the earth from the sun, we have 1,523,850 miles for the distance between the centre of the earth's orbit and the centre of the sun, or the focus of that orbit. Consequently the earth is about double this distance, or 3,047,700 miles nearer to the sun in winter than in summer. In the diagram the earth is represented in four different positions (momentary positions) in its orbit, namely, at mid-spring, mid-summer, mid-autumn, and mid-winter. In all these positions, as well as all round in its orbit, the parallelism of its axis N.S. is preserved, that is, its axis is always directed to the same points of the heavens. Some find it difficult to understand how the earth's axis in all parts of an elliptical orbit can remain parallel to itself. They should remember that the diameter of the earth's orbit is as nothing in comparison with the distance of the fixed stars. If two parallel lines are drawn at the distance of three or four yards from one another they will point directly to the moon, when she is in the horizon. Three or four yards are accounted as nothing in comparison of 240,000 miles, the distance of the moon from us. And perhaps three or four yards bear a greater proportion to 240,000 miles, than 182,862,000 miles, the diameter of the earth's orbit, bear to our distance from the pole-star. The earth's axis is inclined to the plane of its orbit at an angle of $66^{\circ} 32'$, hence it makes an angle of $23^{\circ} 28'$ with the perpendicular to the plane of its orbit; for the perpendicular, represented by the dotted line passing through the centre O, makes an angle of 90° with the plane of the orbit; and subtracting $66^{\circ} 32'$ from 90° leaves the remainder $23^{\circ} 28'$, which is the angle included between the axis, N. S., and the perpendicular or dotted line. The true cause of the variation of the seasons consists in the inclination of the axis of the earth to the plane of its orbit, or, in other words, to the ecliptic. If its axis were *perpendicular* to the ecliptic, the equator and the orbit would coincide; and as the sun is always in the plane of the ecliptic, it would in this case be always over the equator; the two poles would be always enlightened, and there would be no diversity in the length of days and nights, and but one season throughout

the year. Because of the parallelism of the earth's axis it so happens that at mid-spring, or March 20th, this axis is perpendicular to a line drawn to the centre of the sun, and the sun being now directly vertical to the equator there is equal day and night to all places on the earth, the poles being the boundaries of light and darkness; thus



there are twelve hours of light and twelve hours of darkness to every spot on the earth's surface for this day. Hence this day is called the equinox (equal night) of spring, or the vernal equinox. At this time the earth is in the sign Libra, and the sun appears in the opposite sign Aries. As the earth travels onwards from March to June the northern hemisphere comes more into light; and on the 21st of that month the sun is vertical to the tropic of Cancer. The earth is now in Capricornus and the sun appears in the opposite sign of Cancer. At this time the half of the globe is illuminated from the circumference of the north polar circle at the distance of $23^{\circ} 28'$ beyond the north pole N, to the circumference of the south polar circle, at the same distance from the south pole S. At this time there is no day within the south polar circle, but the night continues twenty-four hours; and there is no night within the north polar circle, the day continuing for the same length. As at this point the earth begins to return to a position similar to that of the vernal equinox, and the sun seems to be stationary for two or three days before and after this day, it is called the summer solstice (sun standing), or the tropic (turning) of summer. As the earth now travels on from June to September the sun shines less and less over the north pole, until on the 23rd of that month we find him again vertical to the equator. The days and nights are now again exactly equal all over the earth, or there are twelve hours of light, and twelve hours of darkness to

every spot on the earth's surface for this day. At this time, as at March 20th, the earth's axis is perpendicular to a line drawn to the sun's centre. It is now called the equinox of autumn, or autumnal equinox; the earth is in the sign Aries, the sun appearing in the opposite sign Libra. Since it is summer to every part of the earth where the sun is vertical (and we find it vertical to the equator twice in the year), we see the reason why those living near the equator have two harvests every year. Following the earth in its journey to December we find that when it has arrived in the sign Cancer, at the 21st of that month, the sun appears in the opposite sign of Capricorn, and is now vertical to that part of the earth called the tropic of Capricorn. The half of the globe is now illuminated from the circumference of the south polar circle at a distance of $23^{\circ} 28'$ beyond the south pole, S, to the circumference of the north polar circle, at the same distance from the north pole, N. At this time there is no day within the north polar circle, the night continuing twenty-four hours; and there is no night within the south polar circle, the day continuing twenty-four hours.

In looking at the diagram, you see at the vernal equinox, or March 20th, the whole of the illuminated hemisphere of the globe, because from the representation of its position it is turned in front both to the sun at F, and to you the spectator. At the summer solstice, or June 21st, you see only half the illuminated hemisphere of the globe, because it is turned in front to the sun at F, but sideways to you the spectator, you being supposed outside of the orbit. At the autumnal equinox, or September 23d, you see none of the illuminated hemisphere of the globe, because it is turned in front to the sun at F, but its back is to you the spectator, you being outside of the orbit, and as it were behind the globe. And at the winter solstice, or December 21st, you again see half of the illuminated hemisphere of the globe, because it is turned in front to the sun at F, but only sideways to you the spectator, for the same reason as before. But were you placed in the middle of the orbit, at the point F, you would, by turning round and round to the different positions we have been describing, see the whole of the illuminated hemisphere of the globe at each point of its course. In the course of this revolution the inhabitants of every clime experience, though at different times, a variety of seasons. Spring, summer, autumn, and winter follow each other in constant succession, diversifying the scenery of nature, and marking the different seasons of the year. In those countries which lie in the southern hemisphere of the globe, November, December and January are the summer months: while in the northern hemisphere, where we reside, these are our months of winter. In the northern

and southern hemispheres the seasons are opposite to each other, so that when it is spring in the one it is autumn in the other; when it is winter in the one it is summer in the other. During six months, from March 20th to September 23d, the sun shines without intermission on the north pole; so that there is no night there during all that interval, while the south pole is all this time enveloped in darkness. During six months, from September 23d to March 20th, the sun shines without intermission on the south pole, so that there is no night there during all that interval, while the north pole is, in its turn, deprived of the sun, and left in darkness. From $66\frac{1}{2}^{\circ}$ north or south latitude the inhabitants of these two opposite climes enjoy a length of day during their respective summers varying from 24 hours to six months. The nearer the pole the longer is the day. Our summer is nearly eight days longer than our winter. By summer with us is meant the time which passes between March 20th and September 23d, or between the vernal and autumnal equinoxes; and by winter the time between September 23d and March 21st, or between the autumnal and vernal equinoxes. That portion of the earth's orbit that lies north of the equinoctial contains 184° , while that portion which is south of the equinoctial contains 176° ; being 8° less than the other portion; which is the reason why the sun is nearly eight days longer on the north of the equator than on the south of it. In our summer the earth's motion is through the six southern signs, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces, while the sun appears in the opposite or northern signs; and in the winter the earth moves through the six northern signs Aries, Taurus, Gemini, Cancer, Leo, Virgo, while the sun appears in the opposite or southern signs. In the former case, from March 21st to September 23d, the sun is about 186 days, 11 hours, in passing through the northern signs; and in the latter case only 178 days 18 hours, in passing through the southern signs, the difference being about 7 days, 17 hours. The reason of this difference is that the earth moves in an elliptical orbit, one portion of which is nearer the sun than another; in consequence of which the earth's motion is faster while moving through the northern signs in winter,—it being over three millions of miles nearer to the sun then than in summer; and the nearer the sun the planet approaches the quicker it moves;—and slower while passing through the southern signs in summer; which makes the sun appear to move slower through the northern signs. That the earth is nearer the sun in winter than in summer, is ascertained from the variation of the apparent diameter of the sun. About the first of January, when he is nearest the earth, the apparent diameter is $32', 35''$; and on the first of July, when he is most

distant, it is only $32' 31''$. This proves that the earth is farther distant from the sun in one part of its orbit than in another. In January the earth's motion every hour is at the rate of 69,600 miles; but in July its rate of motion per hour is only about 66,400 miles; a difference of more than 3,000 miles an hour.

The earth completes its revolution in its orbit in 365 days, 5 hours, 48 minutes, and 49 seconds. This period is called a *solar*, or *tropical* year, and is reckoned from the time of the sun's passing the equinoctial point till it again reaches the same spot. The *siderial* year is reckoned from the time of the sun's passing any fixed star till its return to it again, and is $20' 21''$ longer than the solar; the reason of the difference being the retrograde motion of the equinoctial point (called the precession of the equinoxes, which is fifty seconds of a degree every year), by which it travels as it were to meet the sun, so that he comes to it before he has quite completed his circuit. These two periods may be stated thus: solar year 365 days, 5 hours, 48 minutes, 49 seconds; siderial year 365 days, 6 hours, 9 minutes, 10 seconds. In early times the year was taken to consist of 365 days. As, however, the solar year is nearly $365\frac{1}{4}$ days, the day of the equinox soon became wrong; to remedy which Julius Cæsar introduced an additional day into February of every fourth year, thus making that year contain 366. This arrangement was known as the Julian style, and continued in use until nearly the end of the sixteenth century; but as the year is a few minutes shorter than $365\frac{1}{4}$ days, the equinoxes had by this time fallen back as much as 10 days. Pope Gregory XIII. corrected this error by ordering ten days to be left out of the year 1582; and then he modified the Julian style by the following rule: Every year divisible by 4 was to contain 366 days; the even hundreds, however, unless divisible by 400, were to be considered as ordinary years of 365 days; thus 1800 and 1900 are ordinary years, while 2000 will be a leap-year. By this means the error is very nearly eliminated. This alteration, which is known as the Gregorian Calendar, was not adopted in England till 1752, and eleven days had then to be struck out of that year, to correct the error, which had increased one day in 170 years.

In addition to this movement round the sun, by which the seasons are produced, the earth, as we have seen, has a rotation on its own axis, whereby are brought about the changes of day and night. The interval in which this diurnal rotation is completed, as ascertained by the passage of any star across the meridian on two successive days, is called a *siderial day*. It is, in fact, the time occupied by the heavens in making one apparent revolution. In this we have an *invariable measure*; it is, therefore, frequently adopted in the observ-

atories; but for practical purposes of everyday life it would not answer well, as it is 3 minutes, 55".91 seconds shorter than that determined by the sun; and thus clocks regulated by it would gain that amount on the sun every day. The day, therefore, in ordinary use is that reckoned by the movements of the sun, and is known as the *solar day*, being the interval which elapses between two successive meridian passages of the sun. As, however, the distance of the earth from the sun varies in different parts of its orbit, and its diurnal rate of motion varies in like manner, this period is not uniform; its mean length is, therefore, ascertained and taken as the natural or mean solar day. Our clocks are all regulated so as to indicate mean solar time, and hence they are sometimes faster than the sun, and sometimes slower. The greatest discrepancies are about February 10th, when the clock is fifteen minutes faster than true solar time, as indicated by a sun-dial; and October 27th, when it is sixteen minutes slower.

As the sun is further from us in summer than in winter, some naturally enquire why we experience the greatest heat in the former season. The following among other reasons may be assigned, which will partly account for this effect 1. The sun rises to a much greater altitude above our horizon in summer than in winter, and consequently its rays falling more directly upon the earth the thicker and denser will they be, and so much the hotter, when no counter-acting causes from local circumstances exist. 2. The greater length of the day in summer contributes to augment the heat; for the earth and atmosphere are heated by the sun in the daytime more than they are cooled in the night; and, on this account, the heat will go on increasing in the summer; and for the same reason will decrease in winter, when the nights are longer than the days. The main cause is that in summer, when the sun rises to a great altitude, his rays pass through a much smaller portion of the atmosphere, and are less weakened by it than when they come to the earth in an oblique direction, weakened by their passage through the dense vapors near the horizon, and by many refractions and reflections of the atmosphere.

The cause of the changes of the seasons can be exhibited with more clearness and precision by means of machinery than by verbal explanation; and, therefore, those whose conceptions are not clear and well-defined on this subject should have recourse to planetariums, which exhibit the celestial motions by wheel-work. There has been some time ago a small instrument called a Tellurion, manufactured by Messrs. Jones, Holborn, London, which conveys a pretty clear idea of the motions and phases of the moon, the inclination of

the earth's axis to the plane of its orbit, and the changes of the seasons. This instrument was sold at moderate prices according to the quantity of wheel-work, and doubtless it is yet obtainable.

The subject of the seasons and the variety of the phenomena they exhibit, have frequently been the theme of the poet and the philosopher, who have expatiated on the beauty of the arrangement, and the benignant effects they produce; and therefore they conclude that other planets experience the same vicissitudes and seasons similar to ours. This, however, by no means follows, for the cause of the changes of the seasons, as we have them, is owing to the degree of inclination which the earth's axis has to the plane of its orbit, and every planet discovered in our system has a different degree of inclination in that respect, and, therefore, the seasons of each will be different from ours, though they may be analogous. But though in the present constitution of our globe there are many benign agencies and effects, which accompany the revolutions of the seasons, and contribute to the wants and happiness of the earth's inhabitants, yet how few there are out of the great mass of mankind who properly appreciate them, and render to their Creator due praise for circumstances so good, and gifts so rare! Were the habitable parts of the earth generally well cultivated, its marshes drained, and its desolate parts reduced to order and vegetable beauty by the hand of art, and replenished with an industrious and enlightened population, there can be little doubt our seasons would be considerably meliorated, and many physical evils prevented with which we are now annoyed. And all this man has it in his power to accomplish provided he chooses to direct his wealth, and his physical, intellectual, and moral energies into this channel. We are highly favored, but we may to a considerable extent improve our circumstances; and God always assists every effort that is made in the right direction.

THE MOON.

The earth, in its journey round the sun, is attended by a secondary planet, or satellite, the moon. This globe may almost be considered as a part of the earth, for in its revolution round the sun it is not the earth's centre that travels along the orbit, but the centre of gravity of the earth and moon taken together. As the moon is our nearest neighbor in space, and exerts a greater influence on the earth than any of the other heavenly bodies, with the exception of the sun, it has at all times attracted a large share of attention. Its great apparent size and the phases it presents increase the interest. To the eye the moon appears very nearly as large as the sun. This, however, results entirely from its great proximity to us; it is in reality the smallest of the heavenly bodies which can be discerned by

the naked eye. Although its apparent size is nearly equal to that of the sun, yet it would require more than sixty-three millions of globes of the size of the moon to form a globe equal in magnitude to the sun. The moon's distance from us is easily learned from its horizontal parallax, which is sufficiently great to be accurately measured. This varies in different parts of its orbit, but its mean value is about $57'$, and thus the moon's distance is found to be 238,833 miles. We may here observe that the parallax of the moon, or of any heavenly body, is the difference in the apparent position of that body as viewed from two different stations on the earth's surface, which are the length of the earth's semi-diameter, about 4000 miles apart.*

* In order that the general reader may understand what is meant by the diameter or semi-diameter of the earth forming the *base line* of those triangles by which the distances, etc., of the heavenly bodies are measured, we think it necessary to give the following explanation:

In any triangle, as $A B C$, if the length of the side $A B$ be known, and likewise the quantity of the angles at A and B , or the number of degrees and minutes they subtend, be ascertained, we can find the length of the sides $A C$ and $B C$. If $A B$ represent a horizontal plane 100 feet in extent, and $C B$ a tower whose height we wish to determine, and if with a quadrant we find the angle at A to $C A B$ to be 44° , then by an easy process in trigonometry: Radius is to the tangent of A , or 44° : as the side $A B$ 100 feet: is to the height of the tower $C B$; which will give the answer, in this case $96\frac{1}{2}$ feet.

It is on this general principle that the distances and magnitudes of the celestial bodies are determined. But in all cases where we wish to ascertain the dimensions of the different parts of a triangle, the dimensions of at least one side must be given along with two angles; otherwise the length of the different sides of the triangle cannot be determined. Now, in measuring the distance of a heavenly body, such as the moon, the diameter or semi-diameter of the earth is the known side of the triangle by which such a distance is to be determined. In the annexed figure let $E C$, represent the earth; M the moon; and $A B$ a portion of the starry sky. If a spectator at the earth's surface at E , view the moon in the horizon, he will see it in the line M , among the stars at H . But if he view it from the centre of the earth at C , or from the surface at D , which will be the same in effect, he will see it in the line $C D M$, among the stars at S . The difference of position in which the moon is seen as viewed from the surface of the earth E , and the centre C , is called the moon's horizontal parallax, or the arc $S H$, which is subtended by the angle $S M H$, which is equal to the angle $E M C$. In determining the distance of the moon, therefore, we must first find by observation the horizontal parallax, or in other words the angle $E M C$: and the side $E C$, or the semi-diameter of the earth, being known to be about 4000 miles in extent, serves as the base line of the triangle $E M C$; and hence the other sides of the triangle $E M$, and $C M$, or the distance of the moon from the earth, can be found by an easy calculation.

From what has been now stated it will appear that it is of great importance that we have correctly ascertained the figure and magnitude of the earth; for if the length of the base line which we take in our trigonometrical calculations of the moon, or any other celestial body, be incorrectly stated, the whole calculation must be necessarily wrong, and the results false. In the foregoing explanation we have merely given the principle on which astronomers proceed in measuring the distances of the heavenly bodies, without entering into details.

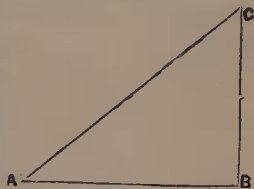


Fig. 108.

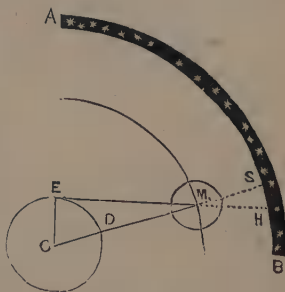


Fig. 109.

This will be understood by reference to the subjoined figure and explanation at the bottom of the page. Knowing the moon's distance, and also the angle which its disc subtends to an observer, we easily ascertain its mean diameter to be 2,153 miles; its circumference 6,764 miles; and consequently its area 14,562,892 square miles. This body revolves in its orbit round the earth, and completes its circuit, reckoning from the time of its passing any star till its return to the same star, in 27 days, 7 hours, and 43 minutes, 11.5 seconds, which period is known as a *sidereal* revolution. The more usual plan, however, of reckoning its period is by reckoning from the time of one full moon to the next. This period is the greater, the reason of the difference being that the moon is full when it is in the part of the heavens diametrically opposite to the sun. Now, if the earth were stationary, this would always happen in the same part of the sky; but as the earth is moving in its orbit round the sun, carrying the moon with it,—by the time, therefore, that the moon has completed its circuit, the earth has travelled round nearly one-thirteenth of its orbit, and the moon must overtake the earth by travelling so much further, before it again comes opposite to the sun. This may be illustrated by the revolutions of the hour and minute hands of a watch or clock. Suppose the hour-hand to represent the sun, and a complete revolution of it to represent a year; suppose the minute-hand to represent the moon, and its circuit round the dial plate a month, it is evident that the moon or minute-hand must go more than round the circle where it was last conjoined with the sun or hour-hand, before it can again overtake him. If, for example, they are in conjunction at 12 o'clock, the minute-hand or moon must make a complete revolution, and above one-twelfth, before they can meet again at a little past 1; for the hour-hand, being in motion, can never be overtaken by the minute-hand at that point from which they started at their last conjunction. This surplus of motion occupies the moon 2 days, 5 hours, 0 minutes, $5\frac{1}{2}$ seconds, which, added to the *sidereal*, makes the *synodical* revolution, or the period between one new or full moon and another. The average length of this period is 29 days, 12 hours, 44 minutes, and 3 seconds. This interval is, therefore, termed a *lunar* month, and during it the moon passes in succession through all its phases. The sun always enlightens one-half of the moon, and sometimes the whole of this enlightened side is turned toward the earth, when she appears a round luminous orb; but this happens only at one point of her orbit, namely, at full moon. At all other parts of her course only a portion of her enlightened side is turned toward the earth; and in one particular part of her orbit, just before new moon, her enlightened side is altogether invisible.

At this part of her course she is invisible, both because she is in the same part of the heavens as the sun, and because the whole of her dark hemisphere is then turned toward the earth. After this it is generally two days or more before any of her enlightened surface is visible. About the third day after the *change*, that is, new moon, she is seen in the western sky at no great distance from the point at which the sun set, and then appears in the form of a slender crescent, having the horns pointed towards the east. The figure annexed will render this more clear. Here the sun must be considered as situated con-

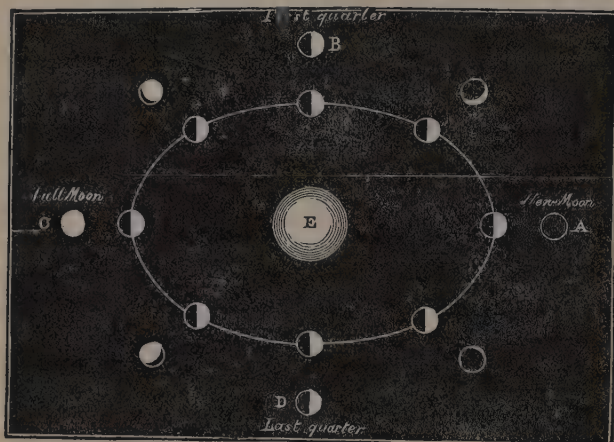


Fig. 110.

siderably to the right of the figure; consequently the illuminated part of the moon will always face that way. E represents the earth, and the moon is represented in eight different points of its orbit, the outer row of discs showing the appearance the moon presents to us when in each of these positions. When at A, her enlightened hemisphere being wholly turned toward the sun, the dark hemisphere is wholly turned toward the earth, and the moon is consequently wholly invisible. As it travels onwards in its orbit towards B, a small portion of its illuminated hemisphere comes into view, presenting the appearance of a slender crescent, having its horns pointed eastward, the sun being now to the west of her. At this time the greatest part of the moon may sometimes be faintly discerned by the naked eye. This is caused by the light which is reflected from the earth on the moon, or *Earth-shine*, as it is termed. A little consideration of the relative positions of the three bodies will show that at the time when the moon is *new* to us, the earth must appear *full* to the inhabitants of the moon; and it appears of a size thirteen times as large as the full moon does to us; for the hemisphere of our globe is thirteen times larger than that of the moon, and thus at this period the most powerful light will be reflected from the earth upon the moon. When

the moon has arrived at B, she presents exactly one-half her illuminated hemisphere to the earth, and this is called her *first quarter*. Still continuing her course, she at length arrives at C, where the sun and the earth are on the same side of her, and accordingly the illuminated hemisphere is turned towards the earth, presenting the entire disc of the full moon. When now, the moon being at C, it is full moon to us, the dark side of the earth is wholly turned toward the moon, and the earth is consequently invisible to the inhabitants of the moon. When the moon is in the increase to us, the earth is decreasing in its illuminated surface to the moon; and conversely, when the moon is in its decrease to us, the earth is in its increase to the lunar inhabitants; so that the phases of the earth, as seen from the moon, are exactly opposite to the phases of the moon as seen from the earth. After passing C, the moon goes through the same series of changes, but in a reverse order; thus she presents, as first shown, a gibbous phase; at D, half her enlightened hemisphere is turned toward us, and it is called her *last quarter*; she then presents a slender crescent, having its horns pointed toward the west, the sun being now rather to the eastward of her; and she finally arrives at A, to go through the same series of changes again.

There is one remarkable circumstance in connection with the moon, which we shall see by and by is not peculiar to her alone among the secondary planets; and that is, that the moon always presents the same side to the earth, so that we never see her opposite hemisphere. This proves that she turns round her circumference just once during her complete revolution round the earth. A great deal of fruitless controversy has frequently arisen upon the question as to whether the moon has an actual rotation or not. The fact that she always presents the one side to the earth is admitted by all. The only question is as to whether or not this motion can be called a rotation. A very little consideration will, however, make it clear that the moon does rotate;* for if the moon had no rotatory motion round her axis, we should see both her hemispheres in the course of every revolution she makes round the earth. This, we are aware, does not at first view appear obvious to those who have never directed their attention to the subject. Any one, however, may convince himself of this fact by standing in the centre of a circle, and causing another person to carry round a terrestrial globe without turning it on its

* Still it is regarded as a very strange circumstance that the moon's axis is invariably turned towards the earth and that the figures on its face always maintain the same position towards the observer on the earth; although if there were a real rotation it is thought the position of these figures should be inverted in the period between new and full moon or during half the rotation. It will be observed that although the common or Newtonian Theory of Astronomy accounts well for the phenomena, it is open to many objections.

axis, when he will see every part of the surface of the globe in succession; and in order that one hemisphere only should be presented to his view, he will find that the globe will require to be gradually turned round its axis, so as to make a *complete* rotation in the time it is carried round the circle. The earth may in this case be considered a fixed station for observation, inasmuch as it turns round its circumference twenty-nine times during one rotation of the moon; and, therefore, the moon (its one hemisphere) is constantly seen by the inhabitants of the earth. Owing to the fact that the moon's axis is inclined $1^{\circ} 31'$ to the plane of its orbit (the orbit itself being inclined to the ecliptic $5^{\circ} 9'$), we occasionally see a little beyond its north pole, and then a similar distance beyond its south pole. Also we sometimes observe the spots on her eastern margin which were formerly visible on the western margin again withdraw themselves behind the limb, while the spots which became concealed behind the eastern margin again appear. These phenomena of the change of spots on the east and west limbs of the moon, as well as toward the north and south poles, sometimes occur for the space of about $3'$ on the moon's disc, or about the eleventh part of her diameter. This is termed the *libration of the moon*; the one, north and south, her libration in latitude; the other, her libration in longitude.

The moon's orbit is, as we have stated, inclined to the ecliptic at an angle of $5^{\circ} 9'$; so that in one part of her course that luminary is above, and in another below the level of the earth's orbit. It is owing to this circumstance that our satellite is not eclipsed at every full moon, and the sun at every new moon, which would regularly occur did the moon move in an orbit exactly coincident with the plane of the ecliptic. The moon's orbit, of course, crosses the orbit of the earth in two opposite points called her nodes; and it is only when the new or full moon happens at or near these nodes that an eclipse of the sun or moon can take place; for it is only when she is in such a position that the sun, the moon, and the earth, are nearly in a straight line, and that the shadow of the one can fall upon the other. The shadow of the moon falling upon any part of the earth causes an eclipse of the sun; and the shadow of the earth falling upon the moon causes an eclipse of the moon. An eclipse of the moon can only take place at *full moon*, when the earth is between the sun and the moon; and an eclipse of the sun can only occur at *new moon*, when the moon comes between the sun and the earth. Lunar eclipses are visible at all places of the earth which have the moon above their horizon, and are everywhere of the same magnitude and duration; but a solar eclipse is never seen throughout the whole

hemisphere of the earth where the sun is visible ; as the moon's disc is too small to hide the whole or any part of the sun from the whole disc or hemisphere of the earth. Nor does an eclipse of the sun appear the same in all parts of the earth where it is visible, but when at one place it is total at another it is only partial.

The moon's orbit, like those of the planets, is an ellipse whose eccentricity is 12,960 miles, or the 1-37th part of its major axis. The moon is therefore at different distances from the earth in different parts of her orbit. When at her greatest distance from the earth she is said to be in her *apogee* ; when at her least distance in her *perigee*. The nearer the moon is to the periods of full or change, the greater is her velocity ; and the nearer to the quadratures or the periods of half-moon, the slower she moves. When the earth is in her *perihelion*, or nearest the sun, the moon's periodical time is the greatest. The earth is at its perihelion in winter, and consequently at this time the moon will describe the largest circles about the earth, and her periodical time will be the longest ; but when the earth is in its aphelion, or farthest from the sun, which happens in summer, she will describe a smaller circle, and her periodical time will be the least ; all which circumstances are found to agree with observation. These and many other circumstances which our space does not allow us to particularize, arise from the attractive influence of the sun upon the moon in different circumstances and in different parts of its course, so as to produce different degrees of accelerated and retarded motion.

The peculiarities of the moon's motions have much and frequently puzzled astronomers and mathematicians, and they render the calculation of her true place in the heavens a considerably difficult task. No less than thirty equations require to be applied to the mean longitude in order to obtain the true, and about twenty-four equations for the obtainment of her latitude and parallax. These problems have, however, been solved, and the moon's motions are now fully understood.

The moon's principal motion is, as has been explained, one of revolution round the earth ; but the earth is at the same time pursuing her journey round the sun ; and thus the combination of these two motions causes it to describe a path, which is in reality a succession of curves. If a pencil were attached to one of the spokes of a wheel, and made to trace a line on a piece of paper, as the wheel travelled onwards we should obtain a rough but somewhat true representation of this path. In her motion round the earth every month the moon pursues her course at the rate of 2,300 miles an hour, but she moves at the same time with the earth in her course

round the sun, so that her real motion in space is much more rapid than what has now been stated—perhaps not less than 70,000 miles an hour—for while she accompanies the earth in her annual motion, which is at an average rate of 68,000 miles an hour, she also moves thirteen times round the earth in the same period, which is equal to a course of nearly twenty millions of miles



Fig. 111.

By means of a good telescope a considerably distinct view may be obtained of the moon. A power of 1,000 brings us, as it were, within 239 miles of its surface, and on very favorable occasions a power even higher than this has been applied; but though a power of 2000 times could be used with distinctness it would make the moon appear no nearer to us than 120 miles, at which distance a living being, though a hundred feet high, could not be seen; for with such a power a space on the moon's surface of 183 feet in diameter could only be perceived as the smallest visible point. This perhaps is the reason why no trace of lunar inhabitants has as yet been discovered. Beside, we ought to consider that when we view objects on the moon's surface, we do not view them in perspective, as we do objects on the surface of the earth, but only obtain a bird's-eye view of them, as we do of objects on the earth's surface, which we view from a balloon elevated in the atmosphere; in which case, when we look down upon groups of human beings we see only the tops of their heads and their shoulders.

Dr. Olbers, a celebrated German astronomer, was fully of opinion from observations he had made "that the moon is inhabited by rational creatures, and that its surface is more or less covered with a vegetation not very dissimilar to that of our earth." Even to the naked eye the moon presents the appearance of an uneven and rugged surface; and telescopic observations confirm this impression. On many parts of its surface high mountains are seen to exist, and

the altitudes of many of these have been approximately measured by observing the shadows cast by them when the sun shines obliquely. One peak, named Newton, is found to have an elevation of nearly 24,000 feet, and several others are very lofty. The elevated summits of these lunar mountains catch and reflect the rays of the sun long before the plains around them, and shine out brilliantly against the dark ground. The most remarkable characteristic feature, however, of the lunar surface, is the number of ring craters which exist on its surface. These resemble huge volcanic craters. In some a spacious plain somewhat circular in shape is surrounded by a lofty

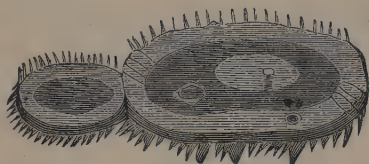


Fig. 112.



Fig. 113.

and rugged mountain-ridge, which almost or quite encloses it. Not unfrequently a solitary peak stands erect in the middle of this enclosed plain, attaining nearly the same height as the surrounding mountain-ridge; in other cases the interior is so extensive that mountain chains run across it. The number of these cavities, especially in the southern hemisphere of the moon, is very great; and some of them are of such a size as to be aptly designated "walled-plains." Even with the most powerful telescope the more minute features of these mountain ranges are unable to be distinguished thus far; the appearance of many of them, however, seems to indicate most strongly the violent action of volcanic forces; and shows that in past time great convulsions of nature have taken place there.

Fig. 111 is a telescopic view of the moon. Fig. 112 is a view of the brilliant spot called Aristarchus, which is situated in the north-east quadrant of the moon's surface, where the shadows of some of the circular cavities, and also the shadows of the mountains may be perceived. Fig. 113 is the spot called Hevelius, which contains an annular cavity and a broken elevation, somewhat resembling an egg. Fig. 114 represents a cavity surrounded by a circular range of mountains, with two central mountains in the middle of the plain, in which the shadows of one side of the circular range and of the central mountains may be seen. Fig. 115 shows another magnified portion of the moon's disc, exhibiting several circular plains, cavities, and other varieties of the lunar surface.

The telescope also brings to view many level plains on the moon's surface, which were formerly thought to be lunar seas, and which still retain the names that were then given to them, though it now appears evident that they are merely dry plains. The Ocean of Storms, the Sea of Clouds, and the Bay of Rainbows are some of these spots. Some astronomers now express the opinion that no water exists on the side of the moon that is turned towards the

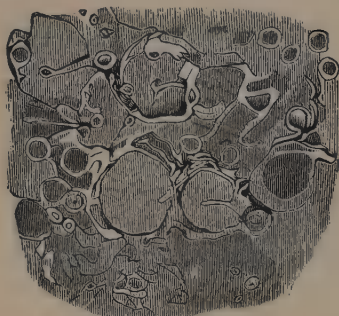


Fig. 114.

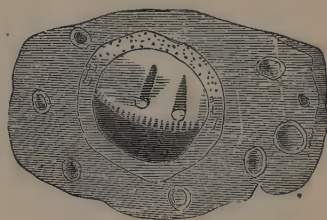


Fig. 115.

earth, however it may be as to its existence on the other hemisphere. Some indeed have supposed that its centre of gravity is nearer to the other side, and that hence all the air and water are accumulated there; but this is merely conjecture.

The best time for making observations on the moon is at the time of the quadratures, as at the time of full moon the shadows of the mountains and peaks, which are hitherto conspicuous, disappear, the sun shining upon them vertically. Accurate maps have ere now been drawn of the moon's surface on a large scale, and the principal mountains have received names, usually names of celebrated astronomers.

The following additional particulars respecting the moon may be stated. 1. The length of a lunar day is equal to nearly fifteen of our days, and the length of the night the same, so that a day and night in the moon equal twenty-nine and a half of our days and nights, or one lunar month. On the hemisphere facing the earth there is moonlight, *earthshine*, nearly all the time the sun is absent; but in the other hemisphere in the absence of the sun there is no light but what proceeds from the stars and planets. Were a lunarian to keep travelling at the rate of ten miles an hour, in a direction at right angles to the moon's axis, he might keep pace with the moon's rotation, and be enabled to live in perpetual sunshine. 2. The light of the moon has been computed to be 300,000 times less intense than that of the sun when shining in an unclouded sky; yet its utility is considerable; and when the full moon shines in its splendor it sheds a cheerful though mild radiance over the surrounding landscape.

3. The moon is, according to the opinion of most astronomers, surrounded by an atmosphere, but it is a very limited one, and of great tenuity, and no clouds or vapors appear to exist in it. It is stated as having been distinctly perceived during the annular eclipse of 1836, when just before the edges of the two bodies met, the light of the sun was seen to shoot through the moon's atmosphere, mollified into twilight. Schroter calculated its height at 5742 feet. They also gave it as their opinion that the moon is replenished with inhabitants; for although seas, and rivers, and a dense atmosphere are not found connected with the lunar orb, and some other of its peculiarities are different from those of the earth, yet these circumstances form no valid objection to its being inhabited with a race of sentient and intelligent beings peculiar to itself, and adapted to their habitation. If telescopes of sufficient powers were in use to disclose to us the particulars as to the surface of the moon, there would, doubtless, be found water existing there, and a race of beings perhaps not very dissimilar to mankind, whose thoughts may sometimes be directed to the glorious orb of the earth in the way of adoration.

Appearance of the Heavens as viewed from the Moon.

Although the moon is the nearest body to the earth, and its constant companion, yet its celestial scenery is in a variety of aspects different from ours. The earth appears the most splendid orb in its nocturnal sky, and its various phases and relative positions form, doubtless, an interesting subject of enquiry and contemplation to its inhabitants. It appears in the lunar sky thirteen times larger than the moon does to us, and sheds nearly a corresponding portion of light on the mountains and vales of the lunar surface. As the moon always presents nearly the same side to our view, so the earth is visible from only one-half of the lunar surface. The inhabitants of the opposite side of the moon, which is never turned toward the earth, will never see the earth in the sky unless they perform a journey to the opposite hemisphere; and those who dwell near the central parts of that hemisphere, which is turned from our globe, will require to travel more than 1500 miles before they can behold the large globe of the earth in the sky. To all those to whom the earth is visible it appears fixed and immovable in the same relative point of the sky; or, at least, does not appear to have any circular motion round the heavens. To a spectator situated in the middle of the moon's hemisphere visible from the earth, the earth appears directly in the zenith, or overhead, and always appears fixed very nearly in the same position. To a spectator placed in the extreme parts of that hemisphere,

or what seem to us to be the margins of the moon, the earth appears always nearly in the horizon; and to spectators in intermediate positions the earth appears at a higher or lower elevation above the horizon, according to their distance from the extreme or central parts of that hemisphere. But though the earth appears fixed nearly in the same part of the sky the slight variation of the moon, called the libration, causes the earth now and then to appear to shift its position a little by a kind of vibratory motion, so that those at the margins of the hemisphere who see the earth in the horizon sometimes see it dip a little below, and at other times rise a little above their horizon. This vibratory motion they are probably disposed at first view to attribute to the earth, which they will naturally consider as a body nearly at rest, but subject to a slight vibratory motion; whereas this apparent vibration proceeds from the actual vibration of the moon itself.

Although the earth seems fixed in nearly the same position, its rotation round its axis is distinctly perceptible, and presents a variety of different appearances. Europe, Asia, Africa, and America present themselves one after another in different shapes nearly as they are represented on our terrestrial globes; and our polar regions, which we have never yet been able to explore, are distinctly seen by the lunarians, who will be enabled to determine whether they chiefly consist of land or water. When the Pacific ocean, which occupies nearly half the globe, is presented to view, the great body of the earth assumes a dusky or sombre aspect, except toward the north, north-east, and north-west; and the islands dispersed through this ocean will exhibit the appearance of small lucid spots on a darkish ground. But when the eastern continent turns round to view, especially its northern regions, the earth appears to shine with a greater degree of lustre. These appearances are diversified by the numerous strata of clouds, which are continually wafted by the winds over the different regions of the earth; and must occasionally intercept their view of certain parts of the continents and seas, or render their appearance more obscure at one time than at another.

The apparent diurnal motions of the sun, the planets, and the stars appear much slower and somewhat different in several respects from what they do to us. When the sun rises in their eastern horizon, his progress is so slow that it requires more than seven of our days to come to the meridian, and the same time before he has descended to the western horizon; for the days and nights on the moon, as before remarked, are nearly fifteen days each, and they are nearly of an equal length on all parts of its surface, as its axis is nearly perpendicular to the ecliptic, and consequently the sun never removes to

any great distance from the equator. During the day the earth appears like a faint cloudy orb, always in the same position; and during the night the stars and planets are visible without interruption for fifteen days, and are seen moving gradually during that time from the east to the western horizon. Though the earth will always be seen in the same point of the sky both by day and night, yet it will appear to be constantly shifting its position with respect to the planets and the stars, which will appear to be regularly moving from the east to the west of it; and some of them will occasionally be hidden or suffer an occultation for three or four hours behind its body. The sun, planets and fixed stars will appear of the same apparent magnitude as they do from the earth; but as the poles of the moon are directed to points of the heavens different from those to which the poles of the earth are directed, the pole-stars in the lunar firmament, and the stars which mark its equator and parallels, are all different from ours; so that the stars in their apparent diurnal revolutions will appear to describe circles different from those which they appear to describe in our sky. The inferior planets, Mercury, and Venus, will generally be seen in the vicinity of the sun as they are seen from the earth; but they will be more distinctly perceived, and are visible for a much longer time, after sunset, than they are from our globe. This is owing, first, to the transparency of the lunar atmosphere, and to the absence of dense vapor near the horizon, which in our case prevent any distinct observations of the heavenly bodies, when at a low altitude; and, secondly, to the slow apparent diurnal revolution of Mercury and Venus. The superior planets, which we are about to consider, will, as with us, be seen in different parts of the heavens, and occasionally in opposition to the sun; but they appear to be continually shifting their positions in relation to the earth, and in the course of fifteen days are seen in the very opposite quarter of the heavens, and in other fifteen days are again seen in conjunction with the earth; and nearly the same appearances are observed in reference to the inferior planets, but the periodic times of their conjunctions with the earth, and their oppositions to it, are somewhat different, owing to the difference of their velocities in their annual revolutions.

The eclipses of the sun which happen to the lunar people are more striking, and total darkness is of much longer continuance than with us. When a total eclipse of the moon happens to us there is a total eclipse of the sun to the lunarians. At that time the dark side of the earth is completely turned toward the moon, and the sun is seen to pass gradually behind the earth until it entirely disappears. The time of the continuance of total darkness in central eclipses is nearly

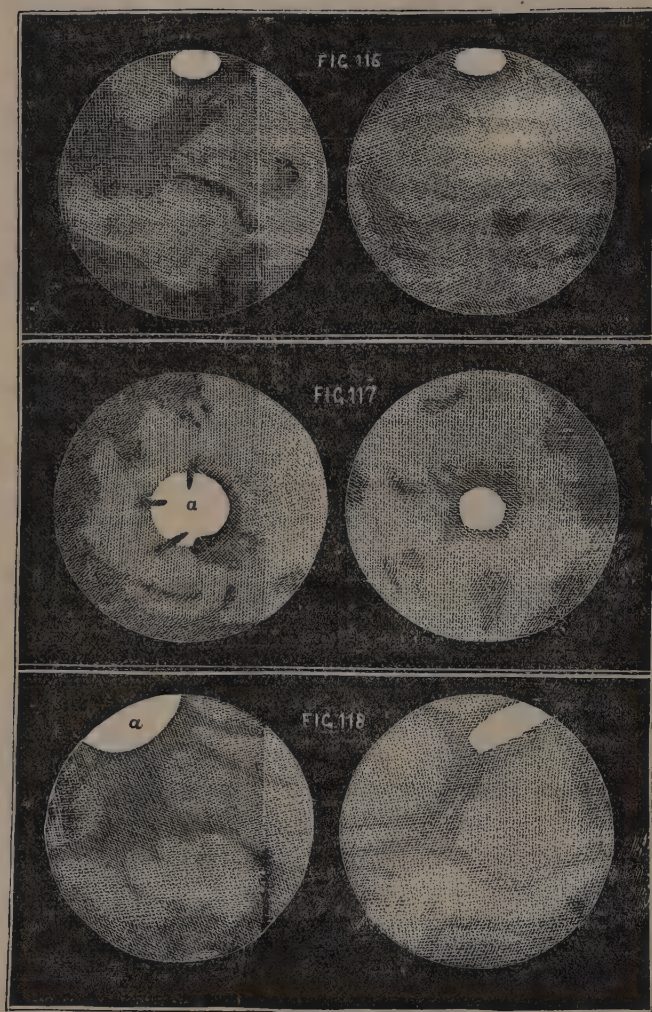
two hours ; and, of course, a total eclipse of the sun must be a far more striking and impressive phenomenon to the inhabitants of the moon than to us. A complete darkness ensues immediately after the body of the sun is hidden, and the stars and planets appear as at midnight. When a partial eclipse of the moon happens to us, all that portion of the moon's surface, over which the earth's shadow passes, suffers a total eclipse of the sun during the time of its continuance. On the other parts of the moon's surface there is a partial eclipse of the sun : and to those who are beyond the range of the earth's shadow no eclipse appears. When an eclipse of the sun happens to us the lunarians see a dark spot, with a penumbra or fainter shades around it, moving across the disc of the earth, which then appears a full enlightened hemisphere, excepting the part that is obscured by the progress of the shadow. The inhabitants of the other hemisphere of the moon can never experience a solar eclipse, as the earth can never interpose between the sun and any part of that hemisphere ; so that they will only know of such phenomena by report, unless they perform a journey for the purpose of observing. The length of the lunar year is about the same as ours, but different as to the number of days, the lunar year having only 12.³⁶⁹² days, each day and night being as long as $29\frac{1}{2}$ of ours ; the length of their year, however, will be considerably difficult for the lunarians to determine. The study of the heavens in the moon is more difficult and complex than with us on the earth. The phenomena exhibited by the earth is doubtless the most difficult for the lunar people to understand. They will be apt to imagine at first view, that the earth is a quiescent body in their firmament, because it appears continually in the same point of the sky, and that the other heavenly orbs all revolve around it. On the other hand they enjoy some advantages in making celestial observations which we do not possess. Those living on the side next the earth, will be enabled to determine the *longitude* of places on the lunar surface with as great facility as we find the *latitude* of places on our globe. For as the earth keeps constantly over one meridian of the moon, or very nearly so, the east and west distances of places from that meridian may be readily found, by taking the altitude of the earth above their horizon, or its distance from the zenith, on the same principle as we obtain the latitude of a place by taking the altitude of the pole-star, or the height of the equator above the horizon. The lunar astronomers likewise possess a singular advantage over our terrestrial astronomers in the length of their nights, which gives them an opportunity of contemplating the heavenly bodies, especially Mercury and Venus, and tracing their motions and aspects for a long time without intermission. Such are some of the celestial phenomena as seen from

the moon. However different these phenomena may appear from those which we are accustomed to behold in our terrestrial firmament they are all owing to the following circumstances; *that* the moon moves round the earth as the more immediate centre of its motions; *that* it always turns the same side to the earth. These slight differences in the motions and relative positions of the earth and moon are the principal causes of all the peculiar aspects of the lunar firmament. But we shall see, as we proceed, that there is an indefinite variety of celestial scenery throughout the universe, so that no one world, or system of worlds, presents the same scenery and phenomena as another.

THE PLANET MARS.

We now pass on to notice the superior planets, that is, those whose orbits lie without that of the earth, concerning the nearer of which our information is more complete than it is about the inferior planets, as the latter are usually too much hidden by the brightness of the sun's rays to be distinctly observed. But the superior planets, since their orbits are outside that of the earth, are at times in opposition to the sun; at this period, too, they are in perigee, that is, at their least distance from the earth, and are, therefore, in all respects most favorably situated for observation. The nearest of these bodies to us is Mars, a name which was given by the ancients to this planet, and signifying the "God of War," which appellation appears to have been given on account of its ruddy or fiery appearance, and because the astrologers believed it to be a promoter of war and bloodshed. The diameter of this planet is 4,920 miles; its circumference 15,456 miles; and consequently its superficial area about 76,043,520 square miles, so that it ranks as one of the smaller planets of our system, its bulk being about one-eighth that of the earth. It revolves round the sun at a mean distance of 139,312,000 miles in an orbit of considerable eccentricity, the difference between its greatest and least distance being about 26,000,000 miles. When the planet is in opposition, both it and the earth are on the same side of the sun, and the distance between them then is about 48,000,000 miles. At this time the planet shines with a brilliancy almost rivalling that of Jupiter or Venus; this happens once in two years and fifty days, its *synodic* period being 780 days. When it happens to be in its perihelion at the same time, its brilliancy is still greater, and consequently this is the most favorable opportunity for telescopic observations upon it. It accomplishes its *periodical* revolution round the sun in 687 days, or about one year and ten months, which is at the rate of about

54,000 miles an hour; but as the Martian day is a little longer than ours, there will not be quite this number of days in his year. But, before it can return to the same relative position in regard to the earth and sun, or, in other words, from one opposition to another, it occupies a period of 780 days, that is, two years and fifty days, as above stated.



Figs. 116, 117 and 118.

When examined at this period with a powerful telescope, Mars is found to exhibit an appearance similar to that which the earth would probably present to the inhabitants of that planet. The surface is diversified with dark portions which represent water, and lighter parts which are the continents. These markings are found to vary a

little at times, probably owing to the presence of large masses of clouds in the planet's atmosphere; the main features are, however, sufficiently prominent to enable maps to be constructed showing the configuration of its surface. The above figures give a general idea of the appearance of the planet when seen through a large telescope. When its atmosphere is clear the land appears to be of a ruddy hue, while the water is somewhat greenish. Figure 116 represents the southern and northern hemispheres as drawn by Messrs. Beer and Mädler, who devoted many years to the examination of Mars; Figure 117 is taken from the observations of Secchi, the eminent Roman observer, at the opposition of 1858. The following are the results of Sir John Herschel's observations on this planet, made with a powerful reflecting telescope. He states that on account of the clearness of its atmosphere he has been enabled to observe with perfect distinctness the outlines of continents and oceans; that the land on its surface is distinguished by a red hue, which imparts to the planet the ruddy appearance it has when viewed with ordinary telescopes, and which its light exhibits to the naked eye. This redness he ascribes to a quality in the prevailing soil like that which our red-sandstone districts would exhibit to an observer contemplating the earth from the surface of Mars. The seas of this planet, he observes, have a greenish hue, altogether resembling the color of our own. These spots, however, are not always to be seen equally distinct, because of the varying transparency of the atmosphere; but when they are distinctly seen they always present the same appearance. Astronomers conclude that this planet is surrounded with an atmosphere of considerable extent, in which clouds at times exist; that the darker spots are water or seas which reflect a much less proportion of the solar light than land, and probably cover about one-third of its surface; that a variety of seasons somewhat similar to ours are experienced on this planet, but of a much longer duration; and that it bears a more striking resemblance to the world in which we dwell than any other planet in the solar system. It was owing to observations taken on this planet by Tycho Brahe having fallen into the hands of Kepler, that the three great laws of planetary motion, commonly termed "Kepler's laws," were discovered. These laws we shall have occasion to notice hereafter. The period of this planet's rotation round its axis has been ascertained to be 24 hours, 37 minutes, 23 seconds. The inclination of its axis to the plane of its orbit is $28^{\circ} 51'$, or a little greater than that of the earth. This is a reason why its seasons should resemble ours to a certain extent. Some time ago (it is now 1884) two moons were reported as discovered accompanying Mars, but since that time little has been said about and still less seen of these alleged minute satellites.

The Scenery of the Heavens, as Viewed from Mars.

From this planet the earth will at certain periods be distinctly seen, but it presents a different aspect, both in its general appearance and its apparent motions, from what it does to the inhabitants of Mercury or Venus. To Mars the earth is an inferior planet, whose orbit is within the orbit of Mars. It will, therefore, be seen only as a morning and an evening star, as Venus appears to us; but with a less degree of magnitude and brilliancy, since Mars is at a greater distance from the earth than the latter is from Venus. It will present to Mars successively the form of a *crescent*, a *half-moon*, and a gibbous phase, but will seldom or never be seen as a full enlightened hemisphere, on account of its proximity to the sun, when its enlightened surface is fully turned toward the planet; nor does it ever appear further removed from the sun, either in the mornings or evenings, than 48° , which is the greatest elongation also of Venus as she appears to the earth, so that the earth never appears in the firmament of Mars about midnight. The earth will likewise be sometimes seen to pass across the sun's disc like a round black spot, as Mercury and Venus at certain periods appear to us; but the planet Mercury will never be seen from Mars, on account of its smallness and nearness to the sun; for at its greatest elongation it can appear only a few degrees from the sun's margin, and is consequently immersed in his rays. The only time when it might happen to be detected is when it makes a transit across the sun's disc. Venus will be as seldom seen by the inhabitants of Mars as Mercury is by us. Our moon may likewise be seen from Mars as a small star accompanying the earth, but never at a greater distance from each other than fifteen minutes of a degree, or about half the apparent breadth of the moon; and with telescopes such as we have, all its phases and eclipses may be distinctly perceived. The planets Jupiter and Saturn will appear to Mars nearly as they do to us. At the time of Jupiter's opposition to the sun that planet will appear a slight degree larger, as Mars is then 50,000,000 miles nearer it than we are; but Saturn will not appear sensibly larger than to us; and it is likely that the largest of the minor planets and the planet Uranus are not more distinguishable than they are from our globe. The point *Aries* on the ecliptic of Mars, one of the points where its ecliptic and equator intersect each other, corresponds to $19^\circ 28'$ of our sign *Sagittarius*. In consequence of this the poles of Mars are directed to points of the heavens considerably different from our polar points, and its equator passes through a different series of stars from that which marks our equator, which will cause the different stars and constellations, in their

apparent diurnal revolutions, to present a different aspect from what they do in their apparent movements round our globe. The sun to Mars appears somewhat over half the size he does to us.

THE MINOR PLANETS OR ASTEROIDS.

In the year 1778, Professor Bode, of Berlin, published a very remarkable law, relating to the distances of the planets from the sun, which, though it is said to have been discovered by Titus, is known as "Bode's Law." It was at first merely a bold conjecture, but has since attracted much attention, as it partly led to the discovery of the first of the minor planets or asteroids. Since, however, the discovery of the last planet, Neptune, it has again fallen to the level of a conjecture. He observes that if we take the numbers 0 3 6 12 24 48 96, each of which, after the second, is double that which precedes it, and add the number 4 to each of them, we obtain the following list, which represents approximately the proportional distance of the

4 7 10 16 28

planets named under them:—Mercury, Venus, Earth, Mars, ———,

52

100

Jupiter, Saturn. Thus, if we take 10 to represent the distance of the earth, we shall find that 4 represents that of Mercury, 7 that of Venus, and so on. No planet was, however, known to occupy the space intervening between Mars and Jupiter, corresponding to the number 28. There was thus a gap left in the system, and Bode stated his conviction that, as the sky was more carefully watched, and better telescopes were employed, such a body would be discovered. Nor was his prediction long unfulfilled, for in the year 1800 six astronomers agreed to establish an association, of twenty-four observers, who should divide the zodiac between them, each taking fifteen degrees, and should search for the supposed planet. This plan soon succeeded, for on January 1st, 1801, Piazzi, an Italian astronomer, discovered a moving body which he at first supposed to be a comet, but which soon proved to be a planet afterward named Ceres, whose position corresponded very nearly with that pointed out by Bode's law. When this fact became generally known, the search was discontinued, as the system appeared now to be complete. In the course of the following year, however, Dr. Olbers discovered a second planet revolving almost in the same period, and at almost the same distance as Ceres. This planet was named Pallas, and its discovery excited great attention among astronomers, such a thing having hitherto been quite unsuspected, as that there should be two planets revolving at almost the same distance from the sun. After some time Olbers ventured a conjecture that these two planets might

be the remains of a single one that had by some means become shattered, and suggested that in this case other fragments might probably be discovered. The search was accordingly renewed, and two planets, which they respectively called Juno and Vesta, were discovered in 1804 and 1807. For many years no more were found; accordingly it was believed that all had been discovered, and that these four, Ceres, Pallas, Juno and Vesta, were the four fragments of a large planet, which had once revolved in an orbit nearly resembling theirs.

At the end of the year 1845, the discovery of a new asteroid was announced by Hencke, and again drew the attention of astronomers to the subject. Many more observers now undertook the task of trying to discover some more of those small bodies; and since that time few years have passed without some fresh names of planets being added to the list, which at present contains more than 100, all of whose orbits are situated in the space between Mars and Jupiter. These generally do not present a well-defined disc in the telescope as the largest planets do, but appear like minute stars of about the twelfth magnitude, so that the only way of observing them is by accurately noting down all the stars visible in a given small portion of the heavens, and then carefully watching, on successive evenings, to ascertain if any of these appear to have changed their positions, or if any fresh points appear among them. Three only of these planets, it is said, have been seen by the naked eye, namely, Vesta, Ceres, and Pallas, and it is only under very favorable circumstances that they can be seen. Nothing definite is yet given us as to the dimensions of these small planets, those mentioned as seen by the naked eye being accounted the largest. Their distances from the sun vary considerably, Flora, the nearest of them, being estimated to have a mean distance of 200,000,000 miles, while the farthest is reckoned as distant above 313,000,000 miles. Their times of revolution are also found to be very different, the two planets just named taking respectively 3.266 and 6.413 years to complete their revolutions.

Owing to their small size and great distances, very little is known as to the nature or character of these small planets; traces of an atmosphere have, however, been discovered round some of them, that surrounding Pallas appearing to have great density.

The theory of Olbers, as to these small planets being fragments of a large planet which had been shattered by the action of some internal force, was adopted by some; while others held that they might have resulted from a planet having been shattered by a collision with a comet; both of which theories to account for the existence of planets which are found to be so widely separated from each other, and to revolve round the sun in such widely different periods in

their respective orbits, seem as unreasonable as they are groundless. The discovery of so many should, however, be sufficient to incite astronomers to continue their researches for many others which yet remain undiscovered in our system.

The Heavens, as seen from the Minor Planets.

To some of these planets, revolving as they do at nearly the same mean distance from the sun, the appearance of the heavens will be very similar. The planet Jupiter will be the most conspicuous object in the firmament of them all, and will appear to most of them at least of three or four times the size and splendor he does to us, so as to exhibit the appearance of a small brilliant moon. Saturn will appear somewhat larger and brighter than to us, but the difference in his appearance will be inconsiderable; nor will Uranus be more distinctly visible than from the earth. At other times, as when near their conjunction with the sun, these planets will appear smaller than to us. Mars will sometimes appear as a morning and an evening star, but he will always appear in the immediate neighborhood of the sun, and will present a surface much less in apparent size than he does to the earth. The earth will rarely be seen on account of its proximity to the sun; and Venus and Mercury will be altogether invisible in all of them unless they may happen to be seen when transiting the solar disc. It is likely that at certain times most or all of these planets will exhibit an uncommon, and occasionally a brilliant, appearance in the firmament of each other. In their revolutions round the sun they may, in parts of their orbits, approach each other so as to be many times nearer each other in one part of their orbits than in another. These different positions in which they may be placed in relation to each other will doubtless produce a great variety in the appearances they present in their respective firmaments; so that at one time they may present in the visible firmament a surface a hundred or even two hundred times greater than they do in other parts of their orbits. It is probable, therefore, that the diversified aspects of these planets in respect to each other will form the most striking phenomena which diversify their nocturnal heavens. In consequence of the great eccentricity of the orbit of some of them, as Pallas, the sun will appear much larger to them in one part of their course than it does in another.

THE PLANET JUPITER.

Beyond this group of small planets, which we have been considering, lies the planet Jupiter, the largest known body connected with

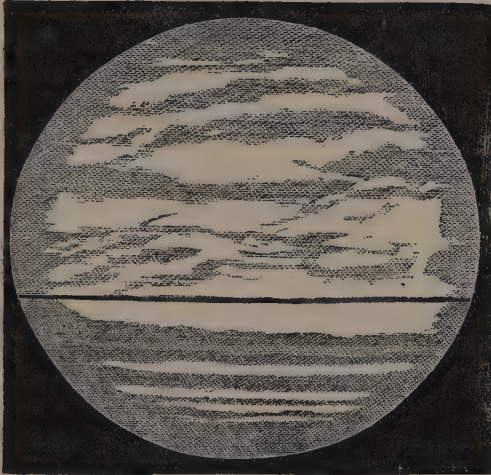
our system, the sun only excepted. The dimensions of the diameter of this planet are given variously, but, taking the smallest amount we find for his equatorial diameter, this is 85,390 miles, or more than ten times as great as that of the earth. Its circumference, therefore, is 268,261 miles, and its superficial area 22,906,806,790 square miles, about 117 times that of the earth. And as globes are to each other as the cubes of their diameters, and the cube of Jupiter's diameter is 622,617,094,819,000 miles; and the cube of the earth's diameter is 495,476,997,497, dividing the former by the latter, the quotient is 1257 nearly, which shows that Jupiter as a solid globe is nearly twelve hundred and fifty-seven times larger than the earth.* Conceive for yourself a superficial area, one hundred and seventeen times larger than that of our terraqueous globe; and of twelve hundred and fifty-seven globes of the size of the earth having to be rolled into one in order to make one of the size of Jupiter; its mass, as compared with the sun's, is estimated as 1 to 160,709. The mean distance of this planet from the sun is 475,693,000 miles; consequently from the earth 380,693,000 miles; and it performs its orbital journey round the sun in 4332.58 days, or a few weeks less than twelve of our years. It moves in its orbit at the rate of 29,000 miles an hour, a rate of speed considerably less than half that of the earth. We always find, however, that the farther the planets are removed from the sun, the less is the rate of speed at which they move, and conversely. The axis of this planet being nearly perpendicular to the plane of its orbit, it cannot have the same variety of seasons as the earth and Mars. Its inclination is, however, $3^{\circ} 5'$, which will produce a slight change of seasons both in the polar and equatorial regions. Had the axis been as much inclined to the orbit as the earth's axis is, the polar regions would respectively have been deprived of the light of the sun for nearly six years without interruption, or one-half of the year of Jupiter. The plane of Jupiter's orbit is inclined very slightly to the plane of the ecliptic, or earth's orbit, and hence it is difficult to determine that exact point at which they intersect, and to ascertain in the usual way the length of its year. This, however, is

* The proportion of the circumference of a circle to the diameter is nearly as 22 to 7,—more accurately as 3.1416 to 1. Therefore if we multiply the circumference by 7 and divide the product by 22, we obtain the diameter nearly. And by multiplying the diameter by 22, and dividing the product by 7, we obtain the circumference. But we obtain the result more accurately by multiplying the diameter by 3.1416 in order to obtain the circumference; and by dividing the circumference by 3.1416 in order to obtain the diameter. The superficial area is obtained by multiplying the square of the diameter by 3.1416; and the solid contents by the

formula $D^3 \times \frac{\pi}{6}$

readily overcome by ascertaining its synodic period, or the time which intervenes from one opposition of the planet to another, and calculating from this its sidereal period.

When Jupiter is examined by means of a good telescope the most remarkable feature which strikes the observer is a number of almost parallel belts which characterize its surface, which may be slightly perceived in the accompanying view of the planet. Sometimes frequent and rapid changes take place in the number and appearance of these belts; at other periods, they remain long almost unchanged. It has been a subject of much speculation among astronomers as to the views which should be entertained respecting the nature of these belts, and the causes which operate in producing the changes which frequently take place among them. Whatever opinion may be entertained on this point, it is pretty evident that the dark stripes, or belts, are the real body of the planet, and the bright spaces between them, or scattered among them, are clouds on its atmosphere, or cloudy zones, liable to variation, which surround the body of the planet at a certain distance from its surface. Distinct markings or spots are sometimes visible on these belts, and remain constant suf-



ficiently long to enable the time which the planet takes in rotation on its axis to be ascertained, which, as a result of many observations, has been determined to be 9 hours 55½ minutes. This is, as will be observed, less than half the time occupied by the earth, or any other of the planets we have yet considered in their diurnal rotation, and is the more remarkable when we consider the vast size of Jupiter.

The equatorial regions of the surface of this planet must thus move about 460 miles a minute, while the speed of the corresponding portions of the earth is only about 17 miles in the same time.

By observing the attractive influence of the planets on each other astronomers are enabled to calculate approximately their respective densities; and thus they find the density of Jupiter to be less than a quarter that of the earth, or in other words that Jupiter, taken bulk for bulk, weighs less than a quarter as much as the earth does. The density of the earth is estimated at 5½ times that of water.

Jupiter, therefore, has a density a little greater than water. Future observations may, however, give somewhat different results as to the time of axial rotation and the density of this planet. The intensity of the solar light on Jupiter is 27 times less than on the earth; this however, will produce a large degree of illumination, if that planet has an atmosphere and surface anything like ours, to reflect the light. An observer situated on Jupiter would have no suspicion that such a globe as the earth has an existence in the universe; all its fancied grandeur and its proud inhabitants are as much unnoticed and unknown there, as is the smallest animalcule in the drop of water by the unaided eye.

The telescope also discloses to us the fact that Jupiter is accompanied by four satellites, or moons. Three of these were discovered by Galileo on January 7th, 1610, when he first directed his newly invented telescope toward the planet; and the fourth a few evenings later. A comparatively low power, such as that of a good opera-glass suffices to show them all distinctly; the telescope Galileo used magnified only 33 times. Three of these satellites revolve round Jupiter in orbits which are almost circular, and very slightly inclined to the plane of the planet's equator. Owing to this circumstance the three nearer ones to the planet are eclipsed every revolution, so that the phenomena of eclipses are far from rare to the inhabitants of Jupiter there being about 4,500 lunar eclipses in one Jovian year, about twelve of our years. It has been deduced from the observations of Sir W. Herschel and others that the moons of Jupiter always present the same side toward the planet, and make one rotation on their axis during one revolution round their primary, which corresponds with what we find in the case of our moon, which, as before shown, always presents the same hemisphere toward the earth, and makes one rotation on its axis while making one revolution round the earth. The eclipses and transits of these bodies are very interesting phenomena, and may easily be observed with an ordinary telescope. A full list of these is given in the "Nautical Almanac" for each year, and scarcely a day passes without some of them being observed. They are frequently used in determining the longitude of any station of observation at sea. When any of the satellites passes between the earth and the planet, it is seen in transit as a bright spot on its face; its shadow is also seen as a dark spot a little distance from it, presenting the appearance of two satellites in transit. The annexed table gives in a concise manner the most important facts concerning the satellites.

Name.	Mean Distance from Planet.	Siderial Period.	Diameter.
Io	267,380 miles.	1 day, 18 hours, 27 minutes.	2,252 miles.
Europa	425,160 "	3 " 13 " 14 "	2,099 "
Ganymede	678,390 "	7 " 3 " 43 "	3,486 "
Callisto	1,192,820 "	16 " 16 " 32 "	2,929 "

The first of these satellites is considerably larger than our moon; the second very nearly of the same size; the third is nearly seven times the bulk of our moon; the fourth is about three times that bulk, so that the whole of Jupiter's satellites are equal to about a dozen of our moon. The circumference of the first satellite is 7,074 miles; of the second 6,294 miles; of the third 10,794; and of the fourth 9,201 miles; the superficial contents of the first satellites would consequently be 15,930,648 square miles; that of the second 13,840,806 square miles that of the third 37,088,184 square miles; and that of the fourth 26,949,924 square miles. The number of square miles, therefore, on Jupiter's four satellites would be nearly 93,809,562 square miles, or nearly ninety-four millions of square miles, which is about double the extent of surface on all the habitable parts of our globe. Doubtless they are replenished with a large number of inhabitants for which they possess such ample capacity. The first satellite, it is seen, revolves at a little further distance from the planet than the moon does from the earth; the second at nearly double that distance; the third at nearly treble that distance, the fourth at nearly six times that distance.

The Heavens as viewed from the Satellites and from Jupiter.

From his satellites Jupiter will appear as a large and resplendent moon in their firmament; sometimes appearing in the zenith; sometimes in the horizon; and in other positions according to the position the spectators occupy on the surface of the satellites. From the first satellite the globe of Jupiter will appear 1459 times larger than the moon does to us, and will exhibit in the course of 21 hours all the diversified phases of the moon, a crescent, a gibbous phase, a half-moon, and a full enlightened hemisphere. Besides, the appearance of the other three moons in its firmament will be highly interesting and sublime. At certain times one of these moons will come so near the first satellite as to appear three times larger than our moon does to us; and at other times it will appear six times smaller than in its former position and a variety of other phenomena will be presented to it from the complex motions of this system of bodies which it would be too tedious here to describe, all of which will present to view objects of surpassing grandeur and sublimity, incomparably superior to what we are accustomed to behold in our nocturnal sky. What has been now stated with reference to the first satellite will also apply in general to the other three satellites, with this difference, that Jupiter will appear of a different magnitude from each satellite; and the magnitudes, motions and aspects of the other satellites will likewise

be somewhat different. In each satellite the great globe of Jupiter, appearing motionless in the sky, will be the most conspicuous object in their firmament. To the second this globe will appear 566 times larger than our moon does to us; to the third 216 times; and to the fourth 70 times the apparent size of the full moon. Each satellite, too, will have a variety of other phenomena peculiar to itself. To each of them the occultations of the other satellites by the body of Jupiter; their eclipses by falling into his shadow; the varieties of the surface of Jupiter, caused by his diurnal rotation; the shadows of the satellites passing like dark spots across his disc; the transits of the satellites themselves like full moons crossing the orb of Jupiter; the diversified phenomena of eclipses, some of them happening when the satellite is like a crescent, or half-moon, and some of them when it appears as a full enlightened hemisphere; and scarcely a single day will pass without some of these phenomena, and many others being observed. The length of the day as has been shown, is different in each satellite.

The only planet which will be conspicuous in the firmament of Jupiter is the planet Saturn, which will appear larger than either Jupiter or Venus does to us, especially at the time of its opposition to the sun. The planet Uranus which is scarcely distinguishable to our unassisted sight, will not be more distinguishable at Jupiter than with us, even at the time of its opposition. Mars will not be seen from Jupiter, both on account of its smallness, and of its proximity to the sun. The earth will be invisible from Jupiter both on account of its small size, its distance, and its being in the immediate vicinity of the sun, immersed in his rays. But although so few of the primary planets are seen in the nocturnal sky of this planet, yet his firmament will present a remarkable appearance by the number of his own satellites, especially as they all perform their journeys round the planet in such short periods of time, and hence their changes occur in rapid succession. These four moons will exhibit many curious and sublime phenomena to the inhabitants of Jupiter, as they run their nocturnal courses through his sky: sometimes they will be seen eclipsing each other; sometimes eclipsing the sun, and at other times the stars; sometimes two, three, and even the whole four will be seen shining in the heavens in one bright galaxy; one perhaps in the form of a crescent, one with a gibbous phase, one like a half moon, and the other with a full enlightened hemisphere. One will be seen moving comparatively slow, and another moving rapidly through the sky, and leaving all the rest behind it. One will be seen under an eclipse, another entering into it, and another emerging from it. One of the satellites will cast the shadows of objects toward the north, another toward the south,

another toward the east, another toward the west, and in all directions upon the surface of Jupiter. These and many other celestial phenomena must be highly interesting to the astronomers and all others connected with this far distant world. On the whole, the planet Jupiter, accompanied by his satellites, presents to our view an object of inexpressible grandeur and sublimity, when we contemplate the vast magnitude of this magnificent globe and the velocity with which it moves, accompanied by its moons, through the regions of space.

THE PLANET SATURN.

The intervals between the planets are now becoming wider and wider, and we have to pass nearly 400 millions of miles beyond the orbit of Jupiter before we reach that of Saturn. This planet may justly be considered as in almost every respect the most magnificent and interesting body within the limits of the planetary system, so far as yet discovered. Viewed in connection with its satellites and rings, it comprehends a greater extent of surface than even the system of Jupiter; and its majestic rings constitute the most singular and wonderful phenomena that have yet been discovered. The mean distance of this planet from the sun is 872,135,000 miles; but owing to the eccentricity of his orbit, the real distance may be greater or less than this by nearly 50,000,000 miles. His mean distance from the earth is 780,705,000 miles, an interval which a cannon ball, flying with its utmost velocity without intermission, could not travel in less than 178 years, and a steam carriage, moving at the rate of twenty miles an hour, could not traverse in less than 4,448 years. Saturn accomplishes his orbital journey round the sun in 10,729.2 days, or nearly $29\frac{1}{2}$ of our years, its motion being over 20,000 miles an hour, or less than one-third that of the earth. In point of size it is next to Jupiter in our system, having an equatorial diameter of 71,904 miles. Here we may observe that astronomers determine the polar diameter of this planet, as well as that of Jupiter, the earth and others, to be somewhat shorter than the equatorial diameter. The difference, however, in any of these cases is very slight, in some of them scarcely at all noticeable. And even these differences are determined variously by different astronomers, and continued observations with more perfect instruments may eventually show all these bodies to be perfect spheres, or that their diameters are equal, excepting so far as they may differ on account of the natural elevations and depressions of the surfaces of the planets. The circumference of Saturn measures 225,893 miles, and its superficial area

16,242,610,272, or over sixteen thousand millions of square miles, an extent of surface over $82\frac{1}{2}$ times that of our terraqueous globe.

The motion of this planet being slow as compared with that of the other planets, if it be once recognized in the heavens near any large fixed star it will be found from year to year making a slow progress to the eastwards of that point. Its apparent motion in that direction in the course of a year is little more than twelve degrees, or less than the moon moves in twenty-four hours. Hence if we perceive this planet in any particular point of the heavens this year, at the same time next year it will appear only about 12° farther to the east.

Notwithstanding the dull appearance Saturn presents to the naked eye, when viewed through a powerful telescope it presents a more regular and magnificent appearance than any other body connected with our system; and were it as near us as Mars, or even Jupiter, it would present a splendid appearance even to the naked eye. The ancients who first traced the motions of the planet could form no adequate idea of the grandeur of Saturn, and of the system of which it is the centre; and their astrologers, on account of his pale leaden hue, accounted him a cheerless unpropitious planet, and as shedding a malign influence upon the inhabitants of the earth. But after ages of darkness and superstition had rolled away the telescope was invented, and by the aid of this noble instrument, which has unfolded to us the wonders of the heavens, a system of revolving bodies were discovered connected with this planet, more wonderful and magnificent than any other object with which we are acquainted. With powerful telescopes four or five belts have been discovered on his surface, which seem broader and less strongly marked than those of Jupiter, and do not appear subject to the variations which are seen in Jupiter's belts, and, therefore, they are thought most probably to form permanent portions of the globe of Saturn, indicating that there is a diversity of surface on this planet, but whether land or water, or any other particular substance, is not yet clearly determined. The quantity of light this planet receives from the sun is only the $\frac{1}{90}$ th part of what we receive; for Saturn is about $9\frac{1}{2}$ times the distance from the sun that the earth is, the square of which is $90\frac{1}{4}$, and the quantity of light the planets receive is in inverse proportion to the squares of their distances from the sun. But that quantity of light is estimated as equal in effect to the light which would be reflected by a thousand full moons such as that connected with our earth. As we have remarked before, however, upon the nature of the atmosphere which surrounds a planet, as well as upon the nature and character of its surface, much depends as to the

degree of illumination which will be enjoyed on it. If the atmosphere of Saturn be as dense and its surface as rough as those of the earth that planet will enjoy a good degree of light. The density of this planet is estimated as less than that of any other planet in our system. The true period of Saturn's rotation on its axis has been difficult to determine; it is, however, set down at a few seconds

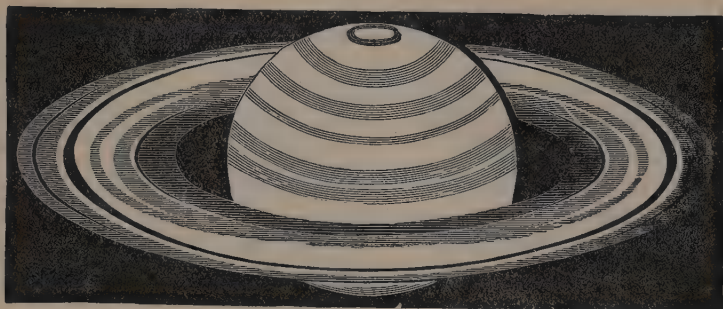


Fig. 120.

short of $10\frac{1}{2}$ hours. It is remarkable that La Place, from physical considerations, had calculated the time of rotation of Saturn to be nearly that stated, before Sir W. Herschel had determined it by direct observation. Future observations with improved instruments may probably disclose something different as to the time of its axial rotation and density. The eccentricity of Saturn's orbit is 49,000,000 miles, which is about the $\frac{1}{36}$ th part of the diameter of its orbit. Its inclination to the ecliptic is $2^{\circ} 29\frac{1}{2}'$.

Saturn is attended with a more numerous train of satellites than any other planet in the solar system that has yet been discovered. Eight moons have been discovered moving around it in solemn grandeur, diffusing light over its surface in the absence of the sun, and greatly diversifying the scenery of its firmament. Two of these, the second and seventh, can only be seen with the most powerful telescopes, and several of the others require a good instrument in order to show them well. Owing to their great distance and small sizes, our information concerning them is quite limited. The annexed table exhibits in a concise form the most important facts known concerning them. The diameters, however, with the exception of that of the sixth, are doubtful:

	Mean Distance from Planet.	Siderial Period.	Diameter.
1st	120,800 miles.	0 day, 27 hours, 37 minutes.	1,000 miles.
2d	155,000 "	1 " 8 " 53 "	? "
3d	191,000 "	1 " 21 " 18 "	500 "
4th	246,000 "	2 " 17 " 41 "	500 "
5th	343,000 "	4 " 12 " 25 "	1,200 "
6th	796,000 "	15 " 22 " 41 "	3,800 "
7th	1,007,000 "	21 " 7 " 8 "	? "
8th	2,314,000 "	79 " 7 " 55 "	1,800 "

Astronomers differ considerably as to the diameters of these satellites; and we incline to think them in general much larger bodies than the diameters given would indicate them to be. The orbits of the three first mentioned of these are much nearer to the planet than that of the moon is to the earth; that of the fourth is a little over that distance; that of the fifth nearly $1\frac{1}{2}$ times that distance; that of the sixth somewhat over $3\frac{1}{4}$ times that distance; that of the seventh over four times, and of the eighth over nine times that distance. The orbits of the seven interior satellites are found to be nearly circular, and very nearly in the plane of the planet's ring, which we shall soon consider; that of the eighth approaches nearer in coincidence with the ecliptic.

*Some phenomena of the Satellites as viewed from the surface of Saturn.
Description of the rings and scenery of the heavens as viewed from Saturn, his satellites and rings.*

These satellites, like those of Jupiter, undergo frequent eclipses; but on account of their great distance from the earth these eclipses are not often observed. It is evident that such a numerous assemblage of moons revolving round this planet at different distances, and in different periods of time, will present a most beautiful, diversified, and sublime appearance in the heavens of Saturn, especially when all the eight satellites appear at the same time above the horizon. Then one will appear as a full moon, another as a crescent, another as a half-moon or with a gibbous phase; one entering into an eclipse, another emerging from it; the inner satellites, on account of their proximity to the planet, presenting the largest discs and the most splendid appearance, and moving with great velocity in their orbits, rapidly passing the other satellites at different rates of motion, and leaving them behind in their course.

On the surface of Saturn a curious effect will be produced, and a diversified scene presented. The shadows of all objects will be projected in different directions by the different satellites, according to their varying positions in the heavens. One satellite will project the shadow of an elevated object towards the east, another towards the west, a third will cast it towards the north, a fourth toward the south, and the shadows will be cast in a variety of directions according to the number of satellites above the horizon, and the positions they occupy in the firmament; and the swift motions of the first three satellites will cause the direction of their shadows rapidly to change. In addition to all this diversity of sublime scenery, there is the grand spectacle produced by the magnificent rings encircling the planet which we shall now endeavor to describe.

This ring surrounding the planet being compound, that is, made up of two or more concentric rings, is the most remarkable peculiarity of Saturn, and, as before remarked, appears to be quite unique in the whole system. To the early observers it caused considerable of curiosity and wonder. Galileo, when he first directed his telescope to the planet, observed that it was somewhat elongated, as if it were oval in shape instead of round, the power of the early telescope not being sufficient, nor their definitions good enough, to show the real cause of the appearance. After some time he advanced an opinion that the planet was really triple, having a small satellite on each side of it. This theory obtained for some time, till gradually the ring began to be presented edgewise to the earth, and then disappeared altogether. This the astronomers of that time were unable to explain, and were, on that account, very much perplexed; but, after the lapse of about half a century, Huygens discovered the real cause of these appearances, and announced that Saturn was surrounded with a slender flat ring, nowhere touching it. He also predicted the period when it would again become invisible, and proved to be very near correct in his dates. After a short time it was discovered that instead of one ring, there were two concentric ones; and numerous recent observations go to show that these again are divided, so that we look upon the whole as a compound or multiple ring, made up of several distinct and separate ones. Three of these are well marked, the innermost of which is commonly known as the *dusky ring*, and seems partially transparent, probably from an accumulation of water near its edge. (See figure 120.) From several phenomena which have been observed, there is thought to be ground for supposing that one or more of these rings may be fluid rather than solid; and most probably they are partially fluid. The diameter of the outer bright ring is estimated at nearly 170,000 miles, and its breadth at upwards of 10,000. The interval between this and the inner bright ring is given by Sir W. Herschel at 2839 miles, which is 700 miles more than the diameter of our moon; so that a body as large as our moon would have place to move between the rings. The breadth of the inner bright ring is 17,000 miles, and that of the dusky ring about half that amount, so that the united breadth of the whole would be about 35,000 miles. Their thickness is, however, small, being variously estimated at from 40 to 250 miles. Astronomers differ somewhat as to the dimensions of these rings, some having them larger than is here given. The superficial contents of these rings, reckoning both their sides and edges, are computed at over 120 times the area of the whole earth; so that they possess ample space for the accommodation of vast numbers of inhabitants,

with which, doubtless, they are abundantly replenished. From the observations of Sir W. Herschel, and others, it has been concluded that there are irregularities on the surface of the rings analogous perhaps to mountains and vales of vast extent; and that the occasional disappearance of the *ansae* may possibly arise from a curvature in their surfaces. Herschel was also of the opinion that the edge of the exterior ring (or that edge which he could observe best with his telescope,) is not flat but curved. This would lead us reasonably to infer that the rings may be inhabited on all their sides and edges, just as our globe is inhabited on all its opposite sides. This astronomer considered, too, that the rings are not less solid than the body of the planet, which consideration was doubtless in the main correct, and which bespeaks a solid uneven surface, at least in part, for the rings. By means of several protuberant points connected with the rings, Sir W. Herschel discovered that it has a swift rotation round the globe of Saturn, which it accomplishes in 10 hours, 32½ minutes. Secchi, however, sets it down at 14 hours, 23½ minutes. The ring is everywhere distant from the surface of the planet over 20,000 miles; so that two or three globes of the size of the earth might be interposed between them. This magnificent appendage keeps always the same position with respect to the planet; is incessantly revolving round it; and at the same time moving along with the planet in its revolution round the sun. When viewed through a good telescope the appearance of the system of Saturn is very beautiful. At times the ring is presented with its edge toward us, and is then almost invisible, being just discernible as a thread of light along which some of the satellites appear to be moving. As the earth moves out of the plane of the planet's equator the ring opens out wider and wider, the projecting sides having the appearance of handles, whence their technical name *ansae*. The opening of the ring attained its maximum in August, 1869; its edge will therefore be directed toward the earth again about the close of the year 1876. The phenomenon of the disappearance of the rings takes place at intervals of fourteen years and nine months, and happens when the planet is in 170° and 350° of longitude, or in the 20th degree of Virgo, and the 20th degree of Pisces. Sometimes the sun is on one side of the plane of the rings, and the earth on the other. The dark side is then turned towards us, and the ring is invisible. In Figure 120 is a good view of the rings as seen in 1852 by Mr. Dawes.

Saturn and his rings would present a more splendid and interesting appearance through our telescopes could we view the rings not obliquely, but as at right angles to our line of vision; but as we

view them our eye is never more elevated than 30° above the plane of the rings. The sun shines on one side of this compound ring during a period of fifteen years, and the regions of Saturn which lie under the dark side suffer a solar eclipse under its shadow during this period. But doubtless this loss of light is amply compensated by the light of the satellites.

Recent observations reveal the fact that the planet is not situated exactly in the centre of the rings, one of the *ansae* being longer than the other; another fact is that the dimensions of the rings appear to vary from day to day in a way that is explained by supposing the rings to be elliptical, and that they would thus present this appearance in their rotation round the planet. This oscillation of the rings about the planet is believed to be necessary to the maintenance of permanent equilibrium in the system of Saturn; for astronomers demonstrate from physical considerations that were they mathematically perfect as to their circular form, and exactly concentric with the planet, "they would form a system in a state of unstable equilibrium, which the slightest external power," (such as the attraction of the satellites,) "might completely subvert by precipitating them unbroken on the body of the planet." "The observed oscillation," says Sir J. Herschel, "of the centre of the rings about that of the planet is in itself the evidence of a perpetual contest between conservative and destructive powers, both extremely feeble, but so antagonizing one another as to prevent the latter from ever gaining an uncontrollable ascendancy, and rushing to a catastrophe." It appears, too, that the ring rotates on its axis in exactly the same time that the planet does, which would go to show the time of rotation determined by the elder Herschel as more correct than that stated by Secchi, for he goes on to say: "The smallest difference of velocity between the body and rings must infallibly precipitate the latter on the former, never more to separate; consequently, either their motion in their common orbit round the sun must have been adjusted to each other by an external power with the minutest precision, or the rings must have been formed about the planet while subject to their common orbital motion, and under the full, free influence of all the acting forces." At the rate of axial motion given to the planet and rings by the Herschels, the parts about the planet's equator must move 22,476 miles an hour, and the exterior circumference of the outer ring 53,176 miles an hour, 886 miles a minute, or fifteen miles a second. We cannot therefore, possibly conceive of any external power as adjusting their motion to each other in their common orbit round the sun "with the minutest precision," nor of the rings being formed about the planet "while subject to their common orbital

motion" with such a velocity, "and under the full, free influence of all the acting forces," such as the centripetal and centrifugal forces of gravity, and the various forces of attraction from different directions in full operation. Such a thing, as we have had occasion to remark before, in a former part of this book, is altogether unreasonable, and inconceivable to us to have taken place. That system is doubtless as permanent as the system of the earth.

In consequence of the vast dimensions of these rings, and the large space they occupy in the firmament of the planet, they will present a magnificent spectacle from the regions of Saturn which lie under their enlightened sides, especially those places which are situated not far from the planet's equator. They will appear as vast shining arches spanning the heavens from one side of the horizon to the other, and holding an invariable position among the stars. Toward the poles of the planet the rings will be quite invisible on account of the convexity of the globe of Saturn interposing between them and the observer; but near the polar regions a segment of the rings will appear, presenting a brilliant appearance in the horizon. Advancing from those regions toward the equator they will appear to span the heavens like brilliant arches of different degrees of magnitude, until at the equator they will appear a complete semicircle. During the space of fourteen years and nine months, which is half of the year of this planet, the sun shines on one side of these rings without intermission, and during a like period he shines on the other side. During nearly fifteen years, therefore, the dwellers on one side of the equator will be enlightened by the sun in the daytime and the rings by night, while those on the other hemisphere, who live under the dark side of the ring, suffer a total eclipse of fifteen years continuance, during which they never see the sun. As the sun ceases to shine upon one side of the ring and is about to shine on the other, the rings will be invisible for a few days or weeks to all the inhabitants of Saturn.

The prominent parts of the celestial scenery of Saturn may be considered as belonging to his own system of rings and satellites, and the views which will occasionally be opened of the firmament of the fixed stars, for but few of the other planets will appear in its sky. Jupiter will appear alternately as a morning and an evening star with about the same degree of brilliancy it exhibits to us, but it will never be conspicuous except near the period of its greatest elongation, and it will never appear removed from the sun further than forty-one degrees, and consequently will not appear so conspicuous or for such a length of time, as Venus does to us. Uranus is the only other planet which will be visible from Saturn, and it

will be distinctly perceptible as a star of the third magnitude when near the time of its opposition to the sun. All the other planets, such as Mars, the Earth, Venus, Mercury, and our Moon, will be far removed from the view of the inhabitants of Saturn, being all in the immediate vicinity of the sun, and immersed in his rays.

But notwithstanding all this the sky of Saturn will present a most diversified and interesting appearance. No pictorial representation, however ample the scale, can convey even an approximate idea of the august and splendid objects which adorn his nocturnal firmament; for besides the rings, which form the most striking and magnificent spectacle, there are the eight moons, three or four of which generally diversify his celestial hemisphere, appearing in different positions and with different phases, and sometimes the whole eight satellites in one bright galaxy may be seen pursuing their different courses among the stars, and rapidly shifting their positions and aspects. Let us picture to ourselves one moon four times as large in apparent size as ours shining in the canopy of heaven; another three times the apparent size of ours in another quarter of the sky; a third apparently twice as large; a fourth about the apparent size of our moon; and a fifth, sixth, seventh and eighth, of different apparent magnitudes; some of them appearing as a crescent, some with a gibbous phase, and others with a full enlightened hemisphere; some rising, some setting, one entering into an eclipse, and another emerging from it; let us conceive such scenes as these, and we may acquire some general idea of the phenomena presented in the heavens of Saturn.

Also, each of the satellites of Saturn will have celestial scenery peculiar to itself. To each of them the globe of Saturn, surrounded by the immense rings, will appear the most conspicuous object in the firmament. From the first satellite, the globe of Saturn will appear 5400 times larger than the moon does to us. The moon occupies only the $\frac{1}{90,000}$ th part of our firmament, but the globe of Saturn will fill the $\frac{1}{17}$ th of the firmament of his first satellite, and the rings will occupy an extent two or three times greater; so that the planet with his rings will appear the most grand and magnificent object in the sky. In some positions on this satellite it will appear in their zenith, or above their heads; in others in the horizon, and in other positions in the sky, according to the position which the spectator occupies upon the satellite. It is not likely that more than half of the globe of Saturn will be visible from this satellite, on account of the interposition of the rings, and as its orbit is very nearly parallel with the plane of the rings, the surfaces of these rings will be seen in a very

oblique direction, but still they will exhibit a very resplendent appearance. When the edge of the outer ring is opposite to the satellite, and enlightened by the sun, it will present a large arch of light in the heavens on each side of the planet, above which will appear half the hemisphere of Saturn. If the satellite turn round its axis in the same time it takes to revolve around its primary, as is most probable, Saturn and his rings will appear stationary in the heavens, for the parallelism of the ring's axis is maintained throughout the whole revolution, and the planet will present to the inhabitants of the satellite a variety of phases, as a crescent, a half-moon, a gibbous phase, and a full enlightened hemisphere. The rings will likewise appear to vary their aspect during every revolution, beside the variety of scenery they will present during their rotation. At one time, they will exhibit large and broad luminous arches; at another time they will appear as narrow streaks of light; and at another like dark belts across the disc of Saturn. And as this satellite moves round the planet in the course of $27\frac{1}{2}$ hours these appearances will be changing almost every hour. The appearances of the seven other satellites, continually varying their phases, their apparent magnitudes, and relative aspects; their positions in respect to the body of Saturn and its rings; their occultations by the interposition both of the rings, and the planet, and the eclipses to which they are often subjected, will produce a diversity of phenomena, and a grandeur unexampled in the case of any other moving bodies in our system. The second satellite when in opposition, or in its nearest position to the first, will be only 35,000 miles distant; and although it is not believed to be larger than our moon, will present a surface sixty times larger than the full moon does in our sky. It will present all the phases of the moon in the course of 33 hours, and will be continually changing its apparent magnitude, on account of its removing farther from or being nearer to the first satellite. The third satellite will appear nearly half as large, and will present nearly the same variety of phases as the other. All the other satellites will appear smaller in proportion to their distances from the orbit of the first; but they will probably all appear larger than or as large as our moon, except the seventh and eighth, which will appear much smaller.

The eighth satellite, which is reckoned among the largest, will have a scenery in its firmament somewhat different from that of the first. As its orbit is considerably inclined to the plane of the rings, its inhabitants will have a more extensive prospect of the rings than those of the seven interior satellites whose orbits are in the plane of the rings, although these objects are beheld at a greater distance, and consequently do not fill so large a portion of its sky. Their appear-

ance, however, will not be without splendor; for although the orbit of this planet is nine and seven-tenths times the distance between the earth and the moon, yet the body of Saturn will appear fourteen times as large as the moon does to us, and the rings will occupy a space proportionately more expansive. The phases of Saturn and his rings, and the various changes of aspect which they assume, will be distinctly seen, though on a smaller scale, than from the inner satellites; for the whole body of the planet as well as the rings will in most cases appear full in view. The intermediate six satellites will appear in all the different phases and aspects above described, and they will never appear to remove to any great distances from the globe of Saturn; but will appear first on one side, then on another, and sometimes either above or below the planet, as the inferior planets appear to us in relation to the sun; and consequently that part of the firmament in which Saturn appears will present a most splendid aspect. In this respect the relative positions of the satellites as seen from the outermost, will be different from their positions as seen from the innermost satellite, when they will sometimes be seen in regions of the sky directly opposite to Saturn. All the other satellites of this planet will have phenomena peculiar to themselves in their respective firmaments, and to each the globe and rings of Saturn will appear of a size in proportion to the distance at which it is from it; to the second satellite Saturn appears 3456 times the size of our full moon; to the third 2160 times; to the fourth 1350 times; to the fifth 683 times; to the sixth 125 times; and to the seventh nearly 15 times; and in all of them a similar variety of phenomena, as in the case of the first, are exhibited on a scale of grandeur and magnificence.

Conceive, then, a firmament in which is shining a globe five thousand times larger than the apparent size of our moon; conceive luminous arches still more expansive surrounding this globe; conceive eight moons of different apparent magnitudes, some of them sixty times larger in apparent size than our moon; conceive, further, all these bodies sometimes appearing in one part of the heavens, sometimes in another, changing their phases and apparent magnitudes, and distance from each other, every hour; appearing sometimes like a large crescent, sometimes like a small one; sometimes shining with a full enlightened face, and sometimes undergoing a total eclipse; sometimes hidden behind the large body of the planet, and sometimes crossing its disc with a rapid motion, like a circular shadow. Suppose these and many other diversified phenomena presenting themselves with increasing variety in the canopy of

heaven, and you will have some slight idea of the grandeur of the firmament as seen from some of the satellitès of Saturn.

On the rings there will be a greater diversity of celestial scenery than any we have yet described. There will be at least ten varieties of celestial scenery, according as the spectator is situated on different parts of the rings. Two opposite varieties of scenery will be exhibited from what appear to us the upper and lower sides of the rings; one variety of scenery will be exhibited from the exterior edge of the outer ring; another from its interior edge; one variety from the exterior edge of the second ring; another from its interior edge; one variety of scenery will appear from the exterior edge of the interior bright ring, another from its interior edge; one from the exterior edge of the dusky ring, another from its interior edge. By referring to the figure, the reader will perceive there are four rings distinctly marked. To describe all these varieties in minute detail would fill a volume. We shall have to confine ourself to a brief description of one of these celestial views. Those who dwell on the sides of the rings will behold the one-half of the hemisphere of Saturn, which will fill perhaps the one-fifth or the one-sixth of their celestial hemisphere, while the other portions of the planet will be hidden by the interposition of the rings. Those who are near the interior and dusky rings are only some 20,000 miles from the surface of Saturn, and consequently the varieties on its surface will be perceived. Those near the outer edge of the exterior ring are about 60,000 miles from the surface of the planet, which will consequently appear to them four times less in size than the former. But being only 18,000 miles from the first satellite at the time of its opposition to Saturn that satellite will appear more than 350 times larger than our moon, will rapidly assume different phases, and will be continually varying in its apparent magnitude; and at its greatest distance beyond the opposite side of the rings it will appear at least 170 times less than when in the nearest point of its orbit; and will exhibit all the intermediate varieties of aspect within a little over a day; so that this satellite will be continually varying its apparent size from an object two or three times the apparent dimensions of our moon to one 350 times greater. The same may be said with respect to the other seven satellites, with this exception, that they will appear of smaller magnitudes, and the periodic times of their phases and their changes in apparent magnitude will be different.

Another object which will diversify the firmanent of those who are on one of the sides of the rings is the opposite portions of the rings themselves. These will appear rising up from each side of the planet like broad luminous arches, each of them somewhat less than

a quadrant, and will fill a very large portion of the sky, so that the inhabitants of the rings will behold a portion of their own habitation forming a very conspicuous part of their firmament, and, at first view may imagine that it forms a celestial object with which they have no immediate connection. Were they to journey to the opposite side of the ring they would see the habitation they had left suspended in the firmament without being aware that the place they had left forms part of the phenomena they behold. As the rings rotate round the planet, and the planet rotates round its axis, the different parts of the surface of the planet will present a different aspect, and its variety of scenery will be successively presented to the view. The eclipses of the sun and of the satellites by the interposition of the body of Saturn, and of the opposite sides of the rings, will produce a variety of striking phenomena, which will be diversified almost every hour.

From the dark sides of the rings which are turned away from the sun for fifteen years a great variety of interesting phenomena will likewise be presented; and during this period the aspect of the firmament will most probably be very varied and striking. This half of the rings will not be in total darkness during the absence of the sun, for some of the eight satellites will always be shining upon it; sometimes three, sometimes four, and sometimes all the eight in one bright assemblage. It is probable too that Saturn, like a large, slender crescent, will occasionally diffuse a mild light, and in the occasional absence of these, the fixed stars will display their radiance in the heavens, which will be the principal opportunity afforded the astronomers of the rings for studying and contemplating those remote luminaries. Those who occupy the exterior rings will behold the interior rings and the opposite segments of their own like vast arches in the heavens; and although only 2,500 miles intervene between the two bright rings, that space is doubtless as impassable as the space which intervenes between us and the moon. The celestial scenery as viewed from these rings will afford a grand and diversified field for telescopic observations, surpassing in variety and sublimity whatever is beheld in any other region of the solar system, by which some of the objects could be contemplated, as if they were placed within the distance of forty or fifty miles.

Thus the planet itself, with all the moving bodies connected with it, presents to the mind a scene of surpassing grandeur and sublimity. Let us suppose ourselves stationed within a few thousand miles of this system; from such a position the globe of Saturn, the rings and moon would appear to fill the greater portion of the visible heavens. Let us conceive this planet nearly a thousand times larger

than the earth, moving through space at the rate of over 20,000 miles an hour, accompanied by his stupendous rings 500,000 miles in circumference; and these rings revolving round the planet, with a velocity of nine hundred miles every minute, and eight other spacious globes, while in their rapid courses at different distances round the planet and his rings; let us endeavor to stretch our imagination to the utmost to represent to ourselves this scene as near as possible to the reality. Supposing ourselves spectators, how grand and terrific and almost overwhelming would be the amazing spectacle! Amidst the emotions which such a sight would excite in us we would exclaim: "Who can understand the operations of the Lord? Great is the Lord; great in his power; and his wisdom is infinite! His power is irresistible; his wisdom is unsearchable; and his agency, as his presence, pervades immensity!

THE PLANET URANUS.

Of the planets which have been discovered beyond the orbit of Saturn, comparatively little is known, owing to their great distance from us. The nearest of these, Uranus, is only faintly visible to the naked eye. It was discovered on March 13th, 1781, by Sir W. Herschel, though it was some few months afterwards before its planetary nature was recognized. While engaged in examining some small stars, he was struck with the appearance of one in particular, and on applying higher powers he found that it seemed to increase in size and presented a faint disc; it also exhibited a proper motion. Herschel accordingly considered it to be a comet, and announced its discovery as such, but it was soon found to be impossible to assign to the wanderer a parabolic orbit, which would account for its movements, and it was then ascertained to be a planet moving in an elliptical orbit at a mean distance from the sun of 1,753,851,000 miles. Some time was spent in deciding on a name for the stranger. The name of the discoverer was suggested. He himself, however, proposed to call it *Georgium Sidus*, the Georgian Star, out of respect to his patron, George III.; but as the names of other planets were derived from the Heathen Mythology, it was finally decided to select a name from this source for it, and Uranus was at length fixed upon. The other names will, however, be occasionally met with in astronomical writings. The diameter of Uranus is a trifle more than 33,000 miles; consequently its circumference is over 103,672 miles; and its superficial area more than 3,421,176,000 square miles, or about $17\frac{1}{2}$ times the land and water area of our globe. Its mass of matter is estimated at about twenty times greater as to bulk than what is contained in

Mercury, Venus, the Earth, the Moon, Mars, Juno, Vesta, Ceres, and Pallas; and, if the mass of its system of satellites were counted in, it would be much greater. Its distance from the sun is about double that of Saturn; and to reach the nearest point of its orbit, a cannon ball flying from the earth thitherward with a velocity of 500 miles an hour would require a period of 389 years; and a steam carriage travelling at the rate of 20 miles an hour without intermission would require more than 9,730 years before it could reach the planet Uranus. The period of this planet's rotation on its axis is as yet unknown; its great distance from the earth preventing us from observing any spots or changes on its surface by which this might be determined. La Place concludes from physical considerations that it rotates about an axis very little inclined to the ecliptic; and that the time of its diurnal rotation cannot be much less than that of Jupiter and Saturn. It moves in its orbit round the sun in a little more than 84 of our years, its period being 30,686.82 days, at the rate of 15,000 miles an hour.

One remarkable feature in connection with this member of our system is the great inclination of its equator to the plane of its orbit, the poles being very nearly in the plane. As a result of this the sun is at different times vertical to nearly all parts of the planet's surface. Its orbit is inclined to the ecliptic at an angle of $46^{\circ}26''$ so that it is never much more than $\frac{3}{4}$ ths of a degree from the ecliptic. This inclination is less than that of any of the other planetary orbits. The eccentricity of its orbit is 85,000,000 of miles, which is about the $\frac{1}{4}$ th part of its diameter. Its mean apparent diameter as seen from the earth is about $4''$. The quantity of light this planet receives from the sun is 360 times less than what the earth receives; for the quantity of light received on any planet is inversely proportional to the square of its distance from the sun. Uranus is about 19 times the distance of the earth from the sun, and the square of 19 is 361, which is the number of times the quantity of light which he receives will be less than what we receive. But this quantity of light is estimated as equal to what we should have were 248 full moons all continually shining on our globe. If the atmosphere of that planet be as dense as ours, and its surface considerably rough, it will enjoy a good share of illumination. The sensible heat may not entirely depend upon the distance of a planetary body from the sun, but partly upon the nature of its atmosphere and the substances on its surface on which the rays of light and heat fall. Light and heat seem only to be required where there are sensitive and intelligent beings existing, and we may rest assured that in all the regions of the universe the nature and constitution of the inhabitants are adapted to their respective habitations. This

immense globe is doubtless replenished with large numbers of sensitive and intelligent creatures.

Several satellites have been discovered revolving round Uranus; but the number that accompany that planet do not appear to be definitely ascertained. Sir W. Herschel states that he discovered six, and two within these have been discovered by Lassell and Struve, so that the number is by many astronomers set down at eight, and their periods of rotation vary from $2\frac{1}{2}$ to $10\frac{1}{2}$ days. Lassell, however, expresses his belief that the total number yet discovered is only four. They all, instead of revolving, as the other planets do, from west to east, have their orbits nearly at right angles to the ecliptic, and move in a direction from east to west. It is reasonable to suppose, however, considering the immense distance and the probable small size (their diameters are not yet ascertained) of these bodies, that the acutest astronomers may possibly make mistakes in their observations of them, for they are almost all faint objects, difficult to be observed even with our best telescopes, and therefore future observations may possibly reveal something different as to the motions of these satellites. If it be confirmed that this apparent anomaly do exist, as we may say, almost at the confines of the solar system, it will indicate that in other systems different states of things exist as to the planets and their satellites besides what we experience in the system to which we belong.

We append a list of the satellites of Uranus. Those given here are numbered 1, 2, 4, 6, in the fuller list:

	Mean Distance from Planet.	Siderial Period.	Diameter.
1st	123,000 miles.	2 days, 12 hours, 28 min.	?
2d	171,000 "	4 " 3 " 27 "	?
3d	281,000 "	8 " 16 " 25 "	?
4th	376,000 "	13 " 11 " 6 "	?

The satellites of Uranus seldom are eclipsed; but as the plane in which they move must pass twice in the year through the sun, there may be eclipses of them at these times; but they can be perceived only when the planet is near its opposition. Some eclipses were seen in 1799 and 1818, when the satellites appeared to *ascend through the shadow of the planet in a direction almost perpendicular to the plane of its orbit*. All these satellites, with perhaps several other that revolve about this planet, will not only shed a flood of light on its surface, but exhibit a splendid and variegated appearance in its nocturnal firmament.

The Heavens as seen from Uranus.

The only one of the planets which will be distinctly visible from Uranus is Saturn, which will appear occasionally as a morning and an evening star, and will appear nearly of the same size as to us; but as it will always be seen near the sun, it will only be visible at certain periods or intervals of fifteen years, and will appear about as near to the sun as Mercury does when seen from the earth. It is not probable that Jupiter will be at all visible to this planet on account of its proximity to the sun. If ever it be visible it will only be for a very short time at intervals of six or eight years. The most splendid and interesting phenomena in the firmament of this planet will be produced by the phases, eclipses, revolutions, and various aspects of his moons. Four of these are given in our list, but it is highly probable that several others are connected with this planet.

Let us suppose, then, one satellite presenting a surface in the sky eight or ten times larger than our moon; a second six times as large; a third four times as large; a fourth twice as large; a fifth about the same size as the moon; a sixth somewhat smaller; and, perhaps, two or three others of different apparent magnitudes; let us suppose two or three of these, of different phases, moving along the concave of the sky; at one time four or five of them displayed through the firmament; one rising above the horizon, one setting, one on the meridian, one toward the north, and another toward the south; let us suppose them at another time all shining in the firmament with full enlightened hemispheres, or with different phases; and we shall have a faint idea of the beauty, variety, and sublimity of the heavens of Uranus. What is deficient in respect to the invisibility of the other planets is amply compensated by his assemblage of satellites, which diversify and illuminate its nocturnal sky.

The sun from this planet has a diameter of only $5'' 16'''$; notwithstanding all this, the light it receives is considerable, as is evident from the brightness it exhibits when viewed with a telescope in the night time, and likewise from the well-known phenomena, that when the sun is eclipsed to us, so as only to have the $\frac{1}{44}$ th part of its disc left uncovered by the moon, the diminution of light is not very sensible; and it has been frequently noticed that at the end of the darkness in total eclipses, when the sun's western limb begins to be visible, and seems no bigger than a thread of silver wire, the increase of light is so considerable, and so quickly illuminates all surrounding objects, as strikes the spectator with surprise. The solar light to Uranus is equal to that of 250 of our full moon.

The scenery of the heavens from the satellites of Uranus will

bear a striking analogy to that observed from the moons of Jupiter ; but if there are six or a greater number of satellites connected with this planet, the firmament of each of its satellites will be more diversified than that of any of the satellites of Jupiter. From its first satellite the globe of Uranus will appear nine hundred and eighty times larger than the moon appears to us, and consequently will appear a very grand and magnificent object in its sky, while all the other moons in different phases will serve both to illuminate its surface, and to diversify the scenery of its firmament. To the second satellite, Uranus will appear five hundred and seven times as large as the moon to us ; to the third, one hundred and eighty-seven times, and to the fourth one hundred and nine times. Each of these satellites will have its own peculiar celestial phenomena ; but after what has been said in the preceding descriptions, and especially with reference to the celestial phenomena from the satellites of Jupiter, it is unnecessary to enter into details with respect to these. These satellites, however, probably move in contrary directions to those of Jupiter and the others ; and, therefore, their celestial phenomena will be exhibited differently.

THE PLANET NEPTUNE.

The history or the discovery of this planet is one of the most remarkable pages in the whole history of astronomy. Uranus, as we have seen, was discovered by accident, and some time elapsed before it was admitted to be a planet. With Neptune the case was very different. About half a century ago, M. Bouvard attempted to calculate accurately the movements of Uranus, but found unexpected irregularities, which he could not then account for. If the planet alone were revolving round the sun, its place could be easily assigned ; but each of the other planets exerts an influence upon it, and these influences are continually varying. All these, however were allowed for, and yet there remained some disturbing cause which drew it out of its assigned place. Accordingly, in the beginning of 1843, Mr. Adams began to investigate the matter for the purpose of ascertaining the place which the exterior planet (should there be one) ought to occupy, and its elements. After nearly two years of diligent enquiry, he announced to the Professor of Astronomy at Greenwich Observatory the results of his investigations. Nothing further was done at the time ; but soon after, Le Verrier, a French astronomer, independently applied himself to the same enquiry, and obtained results closely resembling those arrived at by Mr. Adams. Upon this a search in the locality indicated was resolved upon, but some

time was occupied in commencing it, as the star maps of that part of the zodiac were only imperfect.

Le Verrier then published a revised computation, and on September 18th, 1846, M. Galle, of Berlin, directed his telescope to the spot thus indicated by Adams and Le Verrier. A small star, not mentioned on the maps, was at once seen, and on careful watching proved to be the suspected planet, which had thus by purely theoretical computation had its place marked out among the stars. The problem thus solved almost simultaneously by two different astronomers in England and France was one of the greatest ever solved by the human mind, and reflects honor on both astronomers.

Of the planet itself not much can be said. It revolves round the sun at the mean distance of 2,746,271,000 miles, which is considerably less than that which would be assigned to it by Bode's law. It completes its journey round the sun in 60,126.7 days, or nearly 164½ years. The eccentricity of its orbit is but small. Its diameter is ascertained to be about 36,620 miles; its circumference is, therefore, 115,045 miles, and its superficial contents 4,212,947,900 square miles, or about 21½ times the area of our terraqueous globe.

One satellite has been discovered by Lassell revolving round Neptune in a period of 5 days, 21 hours, 8 minutes, at a distance from the primary of 220,000 miles, and, like those of Uranus, in a direction from east to west. It is evident this satellite must be a body of very considerable size, otherwise it could not be visible at such an immense distance. It is probably much larger than any of the satellites of Jupiter and Saturn, and may far exceed our globe in magnitude. It is not altogether improbable that some of these far distant planets may be surrounded with a ring similar or analogous to that of Saturn.

The discovery of this remote planet constitutes a new era in the progress of celestial science, and evinces the certainty and uniformity of these physical laws by which the bodies of the planetary system are directed. The law enunciated by Newton, that "every particle of matter in the universe attracts every other particle with a force proportional to the quantity of matter in each, and decreasing inversely as the squares of their distances," has obtained here a new confirmation. This law is thus shown to be extensive in its influence, reaching far beyond what was once considered the boundaries of the solar system, and exerting its energies, on every particle of matter throughout the boundless universe.

The first step in the exhibition of that law was the discovery made by Newton that the earth attracts the moon. The principle was also found to explain the revolutions of the planets round the

sun; besides it was found that the revolutions of the secondary planets, or moons, round their primaries, were owing to the same cause. The application of this law also explained certain anomalies in the motions of the moon and planets which were otherwise difficult to account for. A great inequality in the movements of Jupiter and Saturn, which was long unaccounted for, was at length traced to their reciprocal action on one another by the operation of this law. The effects of the attraction of planets that could be observed, and whose names were known, were thereby calculated. In respect to Neptune, the mean distance and position of the planet, its mass, and the form of its orbit, were all unknown. But by its observed effects they were all so well determined as to guide the observer almost to the very point of the heavens where it was first described. This fact stands almost alone in the records of astronomy; there has been no discovery of the same kind before in its annals, and it may lead to other discoveries of a similar kind. Astronomers have now no reason to conclude that they have yet explored the utmost boundaries of the solar system, a body of so great magnitude having been ascertained to exist, and prosecute its journey round the sun at over three times the distance of Saturn. The observation of future years may bring to view many other orbs which have hitherto existed concealed from view in these distant regions, and in other regions also, of our system. Thus, the Creator crowns with success the exertions of human genius in the investigation of His dominions by opening up to our view a more expansive prospect of His boundless and eternal empire.

If we except the satellites of Uranus and Neptune, all the bodies of the solar system, so far as discovered, revolve in the same direction round the sun, and all move within a narrow belt. The planets, however, cannot strictly be said to revolve round the sun, but the sun and the planets revolve about the centre of gravity of the system, which, owing to the preponderating bulk of the sun, lies not far from his own centre. Some idea of the immense magnitude of the sun, may be gathered from the fact that if he were a hollow shell, and the earth placed at the centre, there would be sufficient room for the moon to revolve as she now does at 240,000 miles from the earth, and still there would be some 200,000 miles beyond the moon before the shell of the sun could be reached.

The Heavens as viewed from Neptune.

The only one of the known planets which will be distinctly visible from Neptune is Uranus, which is perceptible occasionally as a faintly appearing morning and evening star of rather less splendor

and magnitude than Mercury appears to us. It is seen most clearly at the periods of its greatest elongation, or at intervals of 42 years, and for a longer period than Saturn appears to Uranus; for while the greatest elongation of Saturn to Uranus is only a few degrees more than that of Mercury to the earth, the greatest distance at which Uranus will appear removed from the sun to Neptune will be fully that at which Venus is seen from the earth at the time of its greatest elongation.

It is very doubtful whether Saturn will be at all visible at Neptune, for at his greatest elongation he cannot be removed from the sun more than 14° , and although of a diameter more than double that of Uranus, and only about double the distance of Uranus from this planet, which would enable him to be seen if at any time his elongation were sufficiently great, yet being in such close proximity to the sun he is at all times inevitably immersed in his rays. Jupiter and all the other planets will never be seen from Neptune unless at times as black spots passing across the sun's disc, when perchance they may be suspected to be globes in transit or spots which pertain to the surface of that luminary. But these phenomena can never be observed by the unassisted sight, so small does the sun's disc appear to Neptune; but may *often* be observed by the help of such instruments as the best of our telescopes, all the other known planets being *inferior* to this. All these great bodies of our system, therefore, surrounded by their retinues of moons will be almost as much unknown at Neptune as if they did not exist, unless it be that their organs of vision there are much superior to ours and their astronomical instruments equal or superior, which would enable them to explore the vicinity of the sun and to closely inspect the planets, especially in transit.

It appears beyond doubt that this planet is attended by several moons, and some respectable astronomers have found reason to think it surrounded by a ring like or analogous to that of Saturn; and, therefore, the most interesting part of his celestial scenery will be produced by the members of his own system. It is not probable that the fixed stars will appear different either in lustre or magnitude than they do to us; but being ignorant of the direction of this planet's axis we cannot tell what are the positions of the different constellations from his different latitudes, or what particular stars will appear at his poles and his equator. The diameter of this planet's orbit, however, being of such immense extent—nearly five thousand five hundred millions of miles—will afford an excellent base line to the astronomers to discover the parallaxes and distances of the stars.

One or two moons have already been discovered and it appears reasonable that only distance prevents others from coming into view. These moons in order to be descried from the earth must be of considerable magnitude. Let us then suppose one moon presenting a surface in the sky a dozen of times as large as that of our full moon, another ten times as large, a third eight times, a fourth seven times as large, and a fifth, sixth, seventh, and eighth, of gradually smaller magnitudes. With all these let us imagine a ring like or analogous to that of Saturn revolving around the planet, within the orbits of all the moons or without those of some of them, and we have a celestial picture almost as sublime and grand as any we have yet contemplated. From the surface of the planet in its motions let us contemplate the motions of the ring as it revolves around it; let us conceive six or eight of these moons appearing at once in the heavens, of different apparent magnitudes and displaying different phases, some appearing as a crescent, some with a gibbous phase, some as a half moon and others as full moons; let us conceive one of these as rising above, another as descending below the horizon, one on the meridian, another approaching to it or departing from it; one north, another south, another east and another west; one entering into an eclipse, another emerging from it; one or two suffering occultations behind the body of the ring, and one or two emerging from their obscuration; let us conceive all these as continually varying their aspects, displaying different phases as in their nocturnal courses they move along the vault of heaven; the ring also varying its aspect during every revolution, besides the variety of scenery it displays during its rotation, considering it to rotate in like manner to that of Saturn; at one time and place, exhibiting a broad luminous arch, at another a narrow streak of light, again appearing as a dark belt encircling a quadrant of the sky, and at other times and places disappearing altogether; and all the varieties of celestial scenery will be different according to the position of the observer on planet, ring, or satellites,—to those on the moons and ring the great globe of Neptune being the most conspicuous object in the sky, filling a large portion of the firmament, appearing to the first satellite 398 times the size of our full moon, and gradually varying its phases and surface scenery, while performing its axial rotations; and to the other moons appearing of gradually decreasing magnitude; let us conceive even this limited representation and we have a picture presented to the mind of extraordinary sublimity and grandeur.

It is true the quantity of light this system receives is but small compared with that the earth receives or even the systems of Saturn and Uranus. This is only the $\frac{1}{840}$ th of what the earth receives; for Neptune is from the sun about twenty-nine times the distance of the

earth from that luminary and the quantity of light the planets receive is in inverse proportion to the squares of their distances from the sun. But supposing the planet's media, its atmosphere and surface, to be as well adapted for reflecting the solar light as the earth's is, and supposing it to be attended with a good number of satellites and perhaps a ring, whose media are equally well fitted for reflecting and refracting the light, and supposing the organs and instruments of vision of the inhabitants to be as good as or better than ours, then there will be a sufficient degree of light for their every purpose in that far distant world, for the quantity is greatly multiplied by reflection and refraction from the media of the planet itself and from those of its attendants. There is, also, we may believe, a sufficient degree of heat there; for the habitation doubtless is in each case adapted to the species which inhabit it. The sun from Neptune has a diameter of only $2''17'''$, but owing to his self-luminosity he appears as large as Venus does to us when that planet appears largest, and affords an incomparably greater quantity of light, his light to Neptune being equal to that of 107 of our full moons were they continually shining on that globe.

We may remark that in the preceding descriptions the apparent magnitudes of Jupiter, Saturn, Uranus, and Neptune, as seen from their satellites, and apparent magnitudes of the satellites as seen from their primaries, and from each other, are only near approximations to the truth, so as to convey a general idea of the scenes presented in their nocturnal firmaments; perfect accuracy not being absolutely required in such descriptions. The variety of celestial phenomena in the firmaments of these bodies is much greater than we have described. Were we to enter into minute details in relation to such phenomena it would require a volume of considerable size to contain their varieties. And were we to consider all the varieties of scenery which characterize *the surfaces* of all these distant worlds, since the colors exhibited on all of them are the same as, or similar to, those exhibited on our globe, we should have a voluminous work.

The satellites of Jupiter, Saturn, Uranus, and Neptune, of which we have endeavored to give a brief description in the preceding pages, form, as it were, so many planetary systems in connection with the grand system of the sun. The same laws of motion and gravitation which apply to the primary planets are also applicable to the secondary planets or moons. The squares of the periodical times are in proportion to the cubes of their mean distances from their primaries. They are subject to the attraction of the primaries as all the primary planets are attracted by the sun; and as the sun in all probability with his whole system moves round some reciprocal centre of

gravity, so the satellites move round their respective primaries, partly by the attractive influence of these planets, and partly by that of the great central luminary. Each of these secondary systems is far more grand and extensive than the whole planetary system was conceived to be in ancient times. Even the system of Saturn, including its rings and satellites, contains a mass of matter much more than a thousand times larger than the earth and moon. The system of Jupiter comprises a mass of matter nearly fifteen hundred times as great as these two bodies; and even that of Uranus or Neptune is eighty or a hundred times the dimensions of our terraqueous globe.

The Attraction of Gravitation explained.

As the sun is called the centre of light and heat to all the bodies revolving around it, so it may also be called the centre of attraction; and the influences of light and heat are invariably distributed to all the planets in the same ratio as the power of attraction, which keeps them revolving in their orbits, that is, in the inverse ratio of the squares of their distances; or, to express it more clearly, the power of the attraction, the light and heat of the sun on one planet is to that on another planet as the square of the distance of the latter from the sun is to the square of the distance of the former. But as some of our readers may not understand this from the bare statement of the fact, we will endeavor to simplify the law of attraction by a familiar illustration.

Suppose two persons, A and B, sitting at the same distance from the fire, both in front of it, at least the one as much as the other; it is plain they will both feel the same degree of heat, for whatever reason may be given to show that A receives more heat than B, the same reason might be assigned to show that B receives more heat than A; therefore they must both receive the same amount of heat each. Now, suppose that B removes to double the distance from the fire that he was at when alongside of A, and A remains in the same place; it might then be supposed that B would receive *only half* as much heat as he did before; or that A would now enjoy double the heat which B would receive in his new position. Such, however, is not the case, for the degree of heat does not diminish at the same rate as the distance increases, as one might expect at first thought; but it diminishes at a much greater rate, and the question is, how much greater? Now well conducted and careful experiments in Natural Philosophy have proved that the heat received at the distance of 2, 3, 4, 5, 6, 7, 8, 9, etc., feet is not $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}, \frac{1}{7}, \frac{1}{8}, \frac{1}{9}$, etc., of the heat received at one foot, but it is $\frac{1}{4}, \frac{1}{9}, \frac{1}{16}, \frac{1}{25}, \frac{1}{36}, \frac{1}{49}, \frac{1}{64}, \frac{1}{81}$ th, etc., of the heat received at one foot. Thus B will receive at *double* the

same distance of A only one-fourth of the heat which A receives; at triple the distance only one-ninth; at four times the distance one-sixteenth, etc. The law of expansive progression is then as follows: Let the heat received at the distance of one foot be denoted by 1, then the heat received at the distance of 2 feet will be denoted by $\frac{1}{4}$, or 1 divided by 2 times 2; the heat received at the distance of 3 feet will be $\frac{1}{9}$, or 1 divided by 3 times 3; the heat received at the distance of 4 feet will be $\frac{1}{16}$ or 1 divided by 4 times 4, and so on. Now dividing 1 by any number gives a result which mathematically is called the *reciprocal* or *inverse* of that number; and multiplying any number by itself gives a result which is likewise called the *square* of that number. But the numbers 1, 4, 9, 16, 25, 36, 49, 64, 81, etc., are the squares of the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, etc., because they are obtained by multiplying the latter numbers each by itself, and the fractions $\frac{1}{4}, \frac{1}{9}, \frac{1}{16}, \frac{1}{25}, \frac{1}{36}, \frac{1}{49}, \frac{1}{64}, \frac{1}{81}$, etc., are called the *reciprocals*, or *inverses* of the squares; and *ratio* means the rate at which anything increases or decreases; hence the force of the heat or amount of heat received from a common fire is in the ratio of the *inverses* of the *squares* of the distances; or, more shortly, in the *inverse ratio* of the squares of the distances. This may be explained in still another way. Suppose A to be placed at two feet distance from the fire, and B at 3 feet distance; then B will receive less heat than A; not in the ratio of 2 to 3, the number which represents their distances, but in the ratio of 2 times 2 to 3 times 3, that is, of 4 to 9 in other words, as 4 is received $2\frac{1}{4}$ times in 9, so A will receive $2\frac{1}{4}$ times more heat than B; and this is what is really meant by the phrase *the inverse ratio of the squares of the distances*.

Thus, having explained the law of the influence of heat on two bodies, or on any number of bodies at different distances from the source of heat in the case of a common fire, we again observe that the law is equally true of the influence of light and of the influence of attraction, upon bodies at different distances from the source of light and of attraction. Thus, we feel and experience that the sun is the great source of light and of heat to this world in which we live; and astronomy teaches us that it is the great centre of attraction; that power which operates upon the earth and the other planets, and causes them to revolve in elliptical orbits around that luminary as the centre of their motions. This power of the sun arises from his great preponderance in weight, for, as stated above, every particle of matter in the universe attracts every other particle with a force proportioned to the amount of matter they contain.* This law, which

* The magnetic attractions of the earth, which appear to make an exception to this statement, are doubtless equilibrated within the earth itself, and by the reciprocal magnetic attractions of co-existing globes.

by long and accurate observation is known to be true, at once conveys to the mind the idea of permanent equilibrium in the universe.

KEPLER AND HIS LAWS.

From the earliest ages of astronomy up to the time of Kepler the planets were reckoned to be only six in number; and this number being mathematically perfect, that is, equal to the sum of all its factors 1, 2, 3, it was imagined that no more planets existed, or might be expected to be found. Kepler, however, earnestly enquired why they should be only six in number; and from his long and careful observations on the motions of the planets deduced certain laws, which are considered as lying at the foundations of astronomical science, which have prepared the way for many new discoveries, and did away with many old and incorrect theories and ideas. This famous astronomer was a pupil of Tycho Brahe, who lived in the latter part of the 16th century. He acquired from his preceptor the habit of accurate observation, and was far more successful than he in the theories which he formed. He was naturally possessed of a quick and lively imagination. He commenced with careful observations, and then formed his theories in accordance with facts; and, proceeding thus, he soon made many and important discoveries. The task to which he devoted his time and energies was to discover the nature of the path described by the planets. Starting with the hypothesis of the sun being in the centre of the system, he began to watch attentively their places, and to simplify matters he confined himself at first to observing the motions of the planet Mars. He calculated the place it should occupy according to the theory of its revolving in a circular orbit, and soon found that the place it really occupied in the sky differed considerably from that assigned to it. This theory was thus at once shown to be incorrect, and he had, therefore, to form a new one by the combination of several circular movements; and again he carefully calculated its position till, just as he seemed to be on the verge of success, the planet once more wandered from the path which he had assigned to it; and once more he had to commence his observations anew from the beginning. In this way he continued to try one hypothesis after another, submitting each to the test of most careful observation, till at length no fewer than nineteen different theories had been proposed, and the movements of the planets compared with those which were calculated by those theories; and still the true solution of the problem remained undiscovered. His perseverance, however, never failed, and he toiled on, though eight long years had been occupied in the task. One important negative

result he had, however, arrived at, and this was that whatever was the nature of the curve the planets described, it was not a circle or a combination of circles. This was one great step toward the solution of the problem. From the earliest ages it had been assumed that, as the circle seemed the perfection of form, all the heavenly bodies must move in circles; but Kepler now untrammelled himself of this theory and then applied himself afresh to the task. In looking at the greatness of his work we must remember that the difficulty is much increased by the fact that our station of observation is itself in rapid motion. Could we view the planets from the sun we should easily see their courses, but as we cannot do this allowance has to be made in every calculation for the motion of our standpoint; and this motion was not then clearly understood.

Having discarded the theory of motion in circles, Kepler now proceeded to try other forms, testing them as before; and the first that occurred to him was the ellipse. He accordingly went through the same series of calculations again, and this time the motion of the planet was found to correspond with that assigned to it by the theory. The great problem of the heavens was now solved, and the joy with which Kepler enunciated the first of the laws which bear his name can scarcely be imagined. This law may be stated as follows: 1. "That the planets revolve in elliptical orbits, situated in planes passing through the centre of the sun; the sun itself being in one of the foci of the ellipse." As to the *foci*: In every circle there is a point, called the centre, such that all straight lines drawn from it to the circumference are equal. No such point is to be found in an ellipse; but in the longest diameter, or the major axis as it is called, two points can be found so situated, that if straight lines be drawn from one to any point in the circumference, and thence to the other, the sum of these lines will always be equal. These points are called



Fig. 121.

the foci. Thus, in the figure, A B is the longest diameter, major axis, C D the shortest diameter, minor axis; and F and F' are the focal points.

A second law enunciated by Kepler is: 2. "That the radius vector drawn from the centre of the planet to the centre of the sun passes over equal areas in equal times in every part of the orbit;" that is, whether the planet be in its aphelion or farthest from the sun, in its perihelion or nearest the sun, or at its mean distance from the sun. Thus, when in the month of December the earth is nearest the sun it is moving much faster than it moves in summer, when it is farthest from the sun; for the radius vector describes equal areas in equal times; and hence we find that the

farther the planets are removed from the sun the slower they move, although their radii vectores may describe equal areas with those of the planets that are situated nearer the sun, and moving faster. Another law Kepler enunciated is as follows: 3d. "That the squares of the periodic times of the planets, that is, of the times of a complete revolution in their orbits, are proportional to the cubes of their mean distances from the sun;" or, in other words, that the square of the periodic time of one planet is to the square of the periodic time of another planet, as the cube of the mean distance of the former from the sun is to the cube of the mean distance of the latter from it. Thus, if we know the distance of a planet we can calculate approximately its time of revolution round the sun; and on the other hand, if we know its periodic time we can ascertain its distance. As an illustration, the distances and periods of Venus and the Earth may be taken, which may be set down in round numbers as follows:

	Period.	Distance from the sun.	The proportion between the
Venus	224 days,	68,000,000	periods here is $\frac{224}{365}$;
Earth	365 "	95,000,000	And the proportion between the distance $\frac{68}{95}$.

If now we take the square of the former quantity, we shall find it to be nearly equal to the cube of the latter.* It will be noticed that the numbers here given for the purpose of illustration are merely approximations. These laws, deduced and proposed by Kepler, at the close of the sixteenth and in the beginning of the seventeenth century, and afterwards mathematically demonstrated by Sir Isaac Newton, are, together with Newton's law of gravitation, accounted the fundamental and invariable laws of the science of astronomy. It will, of course, be observed in what sense they are to be understood as laws; in the common acceptation of the term, law has reference to man, and to the moral world; but neither Kepler nor Newton made these laws; they are simply their deductions, from long observation and experiment, as to how nature is and acts universally.

SIR ISAAC NEWTON AND HIS DISCOVERIES.

The name of Newton stands before Kepler as the discoverer of the law upon which all those of Kepler depend. Kepler seems to have suspected that some such law did exist, but failed to discover it. He seems likewise to have been aware of the fact that the tides were, in some way, influenced by the moon, and that the other heavenly

* The process is as follows by the "Rule of Three:"—

365² : 224² :: 95³ : Distance cubed of Venus from the Sun.
133225 : 50176 :: 857375 × 50176 $\sqrt[3]{322909.7}$. Extracting the cube root we

133225
obtain 68 millions with a small fraction.

bodies were in some way connected so as to influence each other; but he did not discover what this mysterious bond of union was, and, therefore, it was with him a mere conjecture. But Newton applied himself strenuously to clear up this difficulty, and accomplished his task nobly. This great man was born in 1642, the same year in which Galileo died. It is said that his attention was first drawn to the subject of gravitation by observing an apple fall from a tree one day while sitting in a summer-house in his garden. There was nothing remarkable in such a circumstance, for it was an event which might be seen every day. But it set him thinking, and he began to enquire why the apple should fall downwards or towards the ground instead of upwards, or to one side. To most men such a question might have appeared vain and frivolous; to him, however, it seemed an important event towards very great results; and such in reality it proved to be. After careful enquiry he found that all bodies are attracted towards the centre of the earth, and this attraction he called gravitation. The question then arose to him, whether this action was confined to the surface of the earth, or whether distant bodies were attracted in a similar way. The intensity of this force he also believed to diminish with the square of the distance; but the difficulty presented itself, how this was to be tested. Even if a body could have been raised several miles from the earth's surface, this distance would have been so trifling when compared with the earth's radius (4000 miles) that no appreciable difference would have been manifested.

No way, therefore, appeared to him practicable of putting this theory to the test, till at last the idea occurred to him, why he should not use the moon as the falling body, and ascertain the distance through which it falls in any given time, say, for instance, one minute.

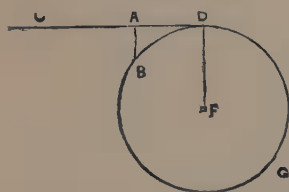


Fig. 122.

This idea, at first, appears absurd, but the annexed figure will enable our reader to understand it. It is known that the moon revolves round the earth in an orbit, almost circular, as G B D. Now, suppose the moon to be at D, its tendency at the moment is to move along in the tangent line D C, and in this direction it would go on moving did not some other force deflect it out of that course; for

every body tends to continue in the state in which it is if not acted upon by forces external to itself; if it is at rest it tends to remain at rest; if in motion, to go on continuously, moving in a straight line. This force, which acted upon the moon so as to draw it out of that straight line and make it describe a curve, Newton sup-

posed to be the attraction of the earth, and determined to calculate whether the amount it deviated from a straight line was such as would arise from the earth's attraction. When the moon has moved into the position B, it is easily seen that the distance it has deviated from its true path is equal to A B. He accordingly calculated what this distance would become after the lapse of one minute, that is, how far the moon would fall toward the earth in that time. He next computed the space through which a body removed to the distance of the moon ought to fall in the same period under the action of the earth's gravitation, and compared these results together. Though this calculation seems simple enough, it really occupied him for many years; and when at length he had completed it, he found a considerable resemblance between the amounts, but not a sufficiently close one to satisfy him, and he, therefore, laid the work aside for a time. After some time, however, he heard that a more accurate determination of the earth's diameter had been effected, and he accordingly repeated his calculations, substituting the new figures; and when at length he had completed his bewildering task, he found the result to agree most accurately. In order to fully satisfy himself of the accuracy of his theory, he went through the same calculations again in reference to some of the planets, and obtained like results; he then announced his general fundamental law before mentioned, that "every particle of matter in the universe attracts every other particle with a force proportioned to the quantity of matter in each, and decreasing inversely as the squares of their distances."

The motion of the planets is thus seen to be compounded of two, the one the motion which the body has in a straight line continuously, the other that arises from the attraction of the body around which they move.

Having attained this result, Newton set himself one more task; and that was, to ascertain, on mathematical principles, the curve in which the planets ought, in these conditions, to move. This was a calculation requiring the greatest amount of mathematical skill. Newton, however, possessed this, and set about the work, fully expecting that the curve must be an ellipse. But he found when the work was completed one which represented not only this, but any of the "Conic Sections," that is, of the curves which may be obtained by cutting a cone. These are, the *circle*, which is the curve obtained when the cone is cut parallel to the base; the *ellipse*, when it is cut a little inclined to this; the *parabola*, when the line passes parallel to one side of the cone; and the *hyperbola*, when it passes parallel to the axis. In any one of these curves, then, a planet may move, under the influence of these general laws; the satellites of Saturn

move in the first; the planets generally in the second, while the comets pursue their courses in parabolas and hyperbolas. This grand discovery of Newton seems to have completed our knowledge of the fundamental laws of motion of the worlds around us. By this we find that all their motions depend upon the two simple laws of *inertia* and *mutual attraction*, and that all their variations can be fully explained by these. And further, deeper investigations, show us that though all the stars are in ceaseless motion, yet their motions run through fixed and certain cycles, so that the very fluctuations of the heavenly bodies are certain indications of the stability of the universe.

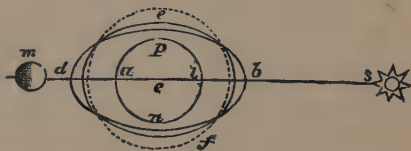
Great as Newton's work was, he did not live to accomplish all his task. He discovered the mutual attraction of the heavenly bodies for one another, but left it to succeeding astronomers to calculate the effects this attraction would produce on the movements of each. That this was a work involving some difficulty will readily be seen if we consider the case of only a single planet. For illustration, let us take Venus; suppose now for a moment that only that planet and the sun existed, we could then easily mark out the exact position of the planet for every moment, if we knew its mean distance and the eccentricity of its orbit. Now add the earth to the system, and we shall find that a disturbing influence is at once introduced by its attraction. As Venus comes into that part of its orbit nearest the earth, it is attracted by the latter, and thus drawn out of its path; its motion is likewise accelerated as it approaches the earth, and retarded as it recedes from it; and the calculation of the amount of this disturbance is rendered more difficult by the fact that the earth is itself moving with a velocity different from that of Venus. When we have made due allowance for this disturbance we have to consider the effects produced by each of the other planets in turn, keeping in mind that they too are all in motion. We thus get some idea of the complication of the problem. It has, however, been completely worked out by modern astronomers, the due allowance being made for each of these disturbing forces; and this has been done with such wonderful accuracy that when certain minute irregularities were perceived in the motions of one of the planets (Uranus), which could not be accounted for by the influence of any of the known ones, it was conjectured that another planet must exist beyond it. Two astronomers accordingly, as we have seen, set about the calculation quite independently of each other, and determined the spot on which a planet should be, if it existed at all; and on turning a telescope to that spot the planet Neptune was discovered, though at no point of its orbit could it come within 130,000,000 miles of the planet whose

course it had been disturbing by its attraction. One fact may be particularly noticed as the result of these investigations; and that is, the absolute stability of the universal system, it being so equally balanced that all these perturbations exactly compensate for one another, and, after a cycle of prodigious length, all return to their original places.

THE TIDES.

The tides, as most readers know, are the alternate risings and fallings of the waters of the seas and oceans, and of bays, friths and rivers connected with them. This alternate rising and falling of the water is distinguished as the "flow" and "ebb" of the tides. They are caused by the attraction of the sun and moon upon the waters of the earth, but especially by that of the latter. Let us illustrate this by a figure. Suppose

a $p l n$ to be the earth, c its centre of gravity; let the dotted circle represent a mass of water covering the earth; let m be the moon in



its orbit, and s the sun. Since the force of gravity diminishes, as the squares of the distances increase, it is evident that the waters will rise at d by the direct attraction of the moon m , and will rise at b by the centre of gravity c being drawn away from it, and leaving the waters on the opposite regions of the earth from the moon to accumulate in like manner in order to maintain equilibrium. Of course when the sun is on the side b of the earth its attraction tends to elevate it still more. It is evident, the quantity of water remaining the same, that a rise cannot take place at b and d without the parts at e and f being at the same time depressed. In this situation the waters of the earth may be considered in somewhat of an oval form. Were the earth and moon without motion, and the earth covered all over with water, the attraction of the moon would rise it up in a heap in that part of the ocean to which the moon would in such a case be vertical; but by rotation of the earth on its axis each part of its surface to which the moon is vertical is presented twice in a little more than a day to the attraction of the moon; and thus are produced two floods and two ebbs. If the moon were stationary, there would be two tides in one day; but because that body is proceeding every day more than 12° in her orbit from west to east, the earth must make more than one rotation on its axis before the same meridian comes again into conjunction

with the moon ; and hence two tides take place in about 24 hours and fifty minutes. In the position of the earth and moon, as given in the figure, the waters are raised at *d* by the direct attraction of the moon, and a tide is accordingly produced ; but when by the earth's rotation *a* comes, in twelve hours afterwards, into the position of *l*, another tide is occasioned by the receding of the waters there from the centre. In those parts of the earth to which the moon is vertical the tides rise highest ; in all other parts, the effect is less, because the force of the attraction acts in a direction more oblique. You will readily understand that the tides are dependent upon fixed and determinate laws which are known ; for if you refer to an Ephemeris, or an Almanac of a certain kind, you will see that the exact time of high water at certain places, say at London Bridge, the port of New York, New Orleans, or Canton, or any other place that may be mentioned in this connection, on the morning and afternoon of every day in the year, is set down.

Those men who are accustomed to work in the harbors, and along the coasts, although they are generally ignorant of the causes which produce the tides, yet know by experience that the time of high water differs on each day about three quarters of an hour, or a little more or less ; and, therefore, if it be high water to-day at six o'clock, they will at a guess promptly tell you that to-morrow the water will not be up till a quarter to seven.

The attraction of the sun, owing to the immense distance at which he is placed from the earth, produces but a small effect in comparison with that produced by the attraction of the moon. Sir Isaac Newton computed that the attractive force of the moon raised the waters in the ocean ten feet, and that of the sun raised it only two feet. When the moon is in her first and last quarters, the attraction of one of these bodies raises the water, while that of the other depresses it, and in order to learn the height to which the water now rises, the attractive force of the sun has to be *subtracted* from that of the moon ; these tides consequently are the lowest, and are called *Neap-tides*. The tides which happen at new or full moon, owing to the direct attraction of the sun and moon, are highest, and are called *Spring-tides*. The height of the tides at these times is found by *adding together* the attractions of the sun and moon. It is evident that at new moon the sun and moon attract the earth on the same side, and that the attractive force of the sun has to be added to that of the moon in order to find the height to which the waters now rise ; and the waters receding from the centre to the side of the earth opposite to the sun and moon, has to heap up there equally in order that the equilibrium of the earth be maintained. And at full moon the powerful attrac-

tion of the moon draws the water towards itself on the side next to it; in consequence of which, and to maintain equilibrium, the water accumulates equally on the opposite side of the earth. The sun now exerting his attraction on this latter side increases the height of the water about one-fifth; and, of course, an equal recession of the waters from the central regions of the earth have to take place towards the side next the moon, in order to counterbalance and to have the height of the waters on the opposite sides of the earth the same, or, at least so that there will be equilibrium. Consequently, at the full moon, as well as at the new, the height to which the tides rise is found by adding together the attractive forces of the sun and moon.

The tides rise higher at some times than at others, owing to the fact that the moon revolves round the earth in an elliptical orbit, or an orbit which is slightly elliptical, and, therefore, approaches nearer the earth in some parts of her course than in others. When she is nearest, the attraction is strongest, and, therefore, the tides rise highest; and when she is farthest from the earth the attraction is the least, and the tides are lowest. They rise also to different heights at different places; in the Mediterranean and Black Sea the tides are scarcely perceptible. At the mouth of the Indus the water rises about 30 feet. The tides are remarkably high on the coasts of Malay, in the Straits of Sunda, in the Red Sea, along the coasts of China, Japan, and in the Bay of Fundy, etc. In general the tides rise highest and with greatest force in places which are narrowest. When the sun and moon are both vertical to our equator, and the moon in *perigee*, then the tides are highest. Speaking strictly, however, these tides do not happen at the equinoxes, but a little before and after them; for in this, as in other cases, the actions do not produce the greatest effects when they are at the strongest, but some time afterwards. Thus the hottest time of the day is not when the sun is on the meridian, but usually between one and four o'clock in the afternoon. Another circumstance is to be taken into account: the sun being nearer the earth in winter than in summer, it is of course nearer to it in October and February than in September and March; and therefore, all these things being considered, sufficient cause may be found why the highest tides happen a little before *vernal* and a little after the *autumnal* equinoxes. The moon's attraction having more effect upon the tides than that of the sun, their height varies with the distance of the moon from the earth; and as they are highest when she is in *perigee*, or nearest the earth, so they are lowest when she is in *apogee*, or farthest from the earth. All these effects are, however, known, and their causes accounted for; and the times of the tides and the heights to which they rise at

certain places are calculated long before, so that all may know these facts.

It is plain from what has been said on this subject, that the phenomena of the tides depend entirely upon two counteracting principles,—that of the attraction of the sun and moon disturbing the waters, displacing the centre of gravity, and destroying the equilibrium of the globe of the earth—and the tendency of the waters themselves to maintain equilibrium about their proper centre of gravity.* All these effects are produced by His agency who is everywhere present, and in whom we live and move.†

ON COMETS.

The planets and their satellites were for some time considered to be the only proper members of our system. This view, however, has been found to be erroneous, as many bodies called comets have had their orbits calculated, and been found to revolve round the sun in regular periods. Comets have from the earliest ages of their discovery attracted a large share of attention from their great size and brilliancy, as well as from the suddenness with which they appear and the rapidity with which they extend these long tails which usually distinguish them. These vast streams of light sometimes extend to the distance of eighty and a hundred millions of miles in length. In past ages and among most people they have been objects of superstitious dread, their appearance being usually considered as portentous of war, famine, pestilence, the death of monarchs, the subversion of kingdoms, or other great evils. On account of this apprehension the periods of their appearances have usually been carefully recorded, and in calculating their orbits considerable assistance is at times derived from these ancient records. The appearance in the year 1066 of a brilliant comet having three tails was considered by many as a sign of the invasion and conquest of William of Normandy. In some of the ancient chronicles it is referred to as furnishing a proof of his divine right to the kingdom of England. But not only were comets considered as harbingers of evil, but fears were often entertained that they should in their course come into collision with the earth and thereby cause terrible results. This feeling still exists to a limited extent, considerable alarm having been manifested by many on the appearance of the comet in 1858, which in one part of its course passed across the earth's orbit. The utter groundlessness of these

* It may be reasonably assumed there is enough of fluid element, whether it be water or analogous to water, pertaining to every celestial sphere as well as the earth in order to the maintenance of its equilibrium in opposition to all the changes which may be wrought in the solid parts by intelligent beings as man, which tend to destroy equilibrium. Witness the piling up of large cities in certain places, and the transference of minerals from their native mines to other parts of the earth.

† Acc. to Bp. Berkeley, the tides rise in the ocean, the air is expanded about the earth, the plants and animals grow upward, etc., contrary to the attraction of the earth but in obedience to the will of a Being, by which he means God. This Being he perceives in the regular order of nature rather than in the capricious character of man.

fears will be seen when people learn something of the physical constitution of these bodies. In ancient times comets were generally supposed to be meteors, exhalations, generated by inflammable vapors in the earth's atmosphere; but now it is ascertained beyond doubt, that comets move in regions far beyond the limits of our atmosphere and form a portion of the solar system. But they differ in many respects from the planetary bodies before described. The planets revolve round the sun in orbits of small eccentricity, which for the most part approach nearly to circles. Comets, on the other hand, move in extremely elongated ellipses, parabolas or hyperbolas, the sun being situated almost at one extremity of their orbits; so that often, at their perihelion, they approach within less than a million or miles of it, and they swiftly dash away for a considerable period from his light and heat. It is clearly only those which move in elliptical orbits which can be periodical, as the parabola does not return again



Fig. 123, COMET OF 1811.

upon itself. About 300 comets have already had their orbits calculated, and of these more than one half are known to be parabolas; so that no second return of these latter can occur, unless, by the attraction of other heavenly bodies, their orbits should be considerably altered. Only five or six have been found to move in hyperbolic orbits. The number of known periodic elliptic comets whose orbits and periods have been ascertained, is about 20. Elliptic orbits have however, been assigned to many others, but no second returns of them have been seen, so as to verify the calculations. In by-gone

days, before the invention of the telescope, but few comets were observed. But now scarcely a year passes without four or five being observed; and frequently the number is greater. For the most part, however, they are so small as only to be visible by the aid of a good telescope. It is only at rare intervals that those large ones which are at once discerned by the naked eye become visible to us. The periods of these, likewise, are as a rule very much longer than those of the telescopic comets, so that the orbits of only a few of them have been determined. The first indication of a comet is usually a faint luminous speck visible with a telescope. This appears gradually but slowly to increase, as the comet approaches the sun; and soon a bright spot, known as the *nucleus*, is discerned in it. This is usually of a circular form, and situated nearer to the side that is directed towards the sun. In telescopic comets this nucleus is not always discernible. As the comet approaches the sun it becomes larger and brighter; the coma, or cloudy mass around the nucleus also becomes less regular; and soon a tail begins to be extended on the side remote from the sun. It is this which forms the most remarkable feature in the appearance of a comet. The tail is usually more or less curved, and points away from the sun; so that when receding from that body the comet travels with his tail foremost. The preceding figure, 123, representing the comet of 1811, gives a good idea of the general appearance of these bodies, the nucleus, coma and tail being all distinctly marked. A period of 3,065 years was assigned to this

Fig. 124.

Fig. 125.



comet. On their return, after completing their orbits, comets seldom present the same appearance as before; hence they cannot be identified by their form, but by the calculation of their orbits. According to many old illustrations some comets have presented very remarkable shapes, sometimes closely resembling swords or sabres. But allowance should be made by us in such cases for the imagination of the artist, excited by the terror occasioned by the approach of the comet. A few comets that have been observed had more than one tail. One

that appeared at the end of 1823, had, in addition to the usual tail, a second one directed toward the sun. The comet of 1744 is, however, the most remarkable, as it is stated that when it approached the sun, the tail was divided into six distinct branches, all curved in the same direction and extending 30° or 40° in length.



Fig. 126.

That called Halley's comet is one that has attracted a greater degree of attention than almost any other, as it was the first whose orbit was calculated, and its period is the longest of all those whose orbits are fully ascertained, and verified by subsequent returns. On its appearance in 1682, just after attention had been excited by the appearance, two years before, of a brilliant one whose motions Newton had investigated, Halley carefully examined its movements, so as to ascertain whether those of any which had previously been noted would in any way accord with them. He soon found that in several respects it seemed to resemble those of 1531 and 1607, and imagined that all three might be in reality appearances of the same body, its period being somewhere about seventy-five and a-half years. This conjecture proved to be correct, and Halley's comet is now reckoned as one of the members of our system, revolving round the sun in a period of seventy-six to seventy-eight years, its greatest and least distances from the sun being 3,200 and 56 millions of miles respectively. The return of this and all other comets is frequently retarded or accelerated by the attraction of the planets which happen to lie near their course. The period given above is, however, the mean period of Halley's comet; and on its last return, in 1835,

the allowances to be made for the influences of the planets were so carefully calculated, that the date of its perihelion passage was predicted within four days. The next return of this body is to occur in the year 1912. By searching back through the list of comets which have been seen, very many appearances of this body can be traced; one as far back as 11 B. C.; and the comet of 1066, already referred to, was, it is believed, an appearance of the same body. It made its appearance in 1456 with a very long tail, considerably curved; and an eclipse of the moon occurred when the comet was in close proximity to it, creating intense alarm.

The comet known as Donati's, which appeared in 1858, will perhaps be remembered by some. It was first seen on the 2d of June, at Florence, by Dr. Donati, after whom it was named. Its movements for the next two months were very slow. Towards the end of August, faint traces of a tail began to appear, and it soon became visible to the naked eye. It accomplished its passage round the sun on the 29th of September, its tail vastly increasing in length, being on the 10th of October upwards of 50,000,000 miles long. On the 5th of October the comet passed in front of the star Arcturus, and though a portion of the tail, at its densest part, having a thickness

Fig. 127.

Fig. 128.



Fig. 124 is a view of a comet as seen on October 21st, 1807, by Schroeter; figure 125 is a view of the same comet as seen on the following evening, October 22. Figure 126 represents the tail of the splendid comet of 1744, which was divided into six branches. Fig. 127 represents the comet of 1661 as seen by Hevelius; the atmosphere or nebulosity surrounding the nucleus of this when viewed at different times varied in its extent, as likewise the tail in the length and breadth. Fig. 128 represents a class of comets which have their tails somewhat bent, which some suppose to be owing to the resistance of the ethereal fluids through which they move.

of several thousand miles, intervened between the observers and the star, its light was not so much enfeebled as it would have been by the faintest fog on the earth's surface. While the tail of this comet was being thrown out the nucleus was watched, and presented the appearance of a series of coverings being thrown off, and passing into the tail. As many as seven of these envelopes were distinctly ob-



DONATI'S COMET.

served. The tail appeared much brighter at the edges, and a dark band passed down the middle as if it consisted of a hollow cone. The observations on this comet were very numerous, and there is little doubt but that it revolves in an elliptic orbit, completing its journey in about 2000 years. The comet that appeared in 1861, was also a very remarkable one from the suddenness with which it came to view. It was discovered in the Southern hemisphere about the middle of May; and in the latter part of June it was seen in the Northern hemisphere, only a portion of the tail being above the horizon in England, the 20th of this month. Its brightness was very remarkable, being greater than that of the one seen in 1858. Its tail, when at its greatest length, extended over nearly 80° , and was perfectly straight. It was, however, somewhat fan-like in shape. The following figure represents it, and shows the appearance of the nucleus when the tail was a throwing off. Mr. Hind states that it is probable that on the 30th of June, the earth actually passed through

the tail of the comet; and it is remarked in connection with this that on that day Mr. Lowe, and one or two other observers, noticed a peculiar phosphorescent glare in the sky.



COMET OF 1861.

M. Biela, in 1826, discovered a comet which has since been known by his name, and has become remarkable. Observations made at different times soon showed that it moved in an elliptical orbit, and its period was found to be about $6\frac{1}{2}$ years. Its return, in 1832, took place within a few hours of the predicted time. On its next visit to the sun it was invisible, owing to the position of the earth with respect to it and the sun being such that the comet was lost in the sun's light. Towards the close of 1845, when it again returned, a strange phenomenon was seen. The comet, which at first appeared almost circular, gradually became lengthened out, and at length divided into two parts, which continued to travel separately until lost sight of. Both parts reappeared in 1852, the distance between them having somewhat increased in the mean time. In 1859 it was again in an unfavorable position for observation, and so was not seen; and in 1866, from some unknown cause, it could not be found. Whether it has been altogether thrown out of its course by the attraction of some planet near which it passed, or what has become of it, is a matter that astronomers are at a loss to ascertain. There are several other comets which have a strange history; but we can only refer to one, Encke's, which performs its revolution in a period of

about $3\frac{1}{2}$ years. More appearances of this comet have been carefully observed than of any other, and by a comparison of these different observations Encke found that on each return it accomplished its passage round the sun in $2\frac{1}{2}$ or 3 hours earlier than he expected. Its period thus appears to be diminishing by this amount, in each revolution. He conjectured that this might be accounted for by supposing that all space is occupied by an extremely rare medium, but yet one sufficiently dense to retard the comet to this extent, and thus to cause it gradually to be falling in towards the sun. Other conjectures have been made, but the matter is still a moot point among astronomers.

Of the physical constitution of these bodies comparatively little is as yet known. They are believed to be self-luminous masses of vapor, revolving round the sun. Some have supposed that in a few comets a solid nucleus exists; but the evidence on this point does not appear to be very strong, and if one does exist it evidently is very small. The general opinion, however, is against its existence at all, and the great majority of comets are known to be devoid of one. That the mass of these bodies is extremely minute is seen by the way in which they are affected by many of the heavenly bodies which they approach. Lexell's comet, for instance, when approaching the sun in 1770, passed so near to the planet Jupiter that it was entangled for several months among his satellites. Its orbit was completely changed by this contact, but no effect whatever could be discerned upon the satellites; whereas, had the comet's mass been at all appreciable, their times of revolution might have been slightly modified. So also the comets of 1858 and 1861, though they both passed near the earth, did not alter the length of our year by a single second. The fact that the light of even faint stars is scarcely at all diminished by passing through the tail of a comet has frequently been observed. It is known that the whole mass of a comet is so small that even though one should come into full collision with the earth no injurious effects would follow from the blow. Several large comets have at times passed so close to the sun as almost to graze his surface. The heat, therefore, to which they were exposed must have been extremely great, but they appeared not to be at all affected by it. The number of comets connected with our system has hitherto been found impossible to enumerate. Some have imagined that it must, indeed, be very great. But this fact is certain, that there may be many which from their position are altogether hidden from our view. The following is a list of the principal comets recognized as belonging to the solar system:

Name.	Period.	Date of next appearance.
De Vico's	5469 years.	October, 1872.
Winnecke's	5541 "	February, 1875.
Brorsen's	5581 "	January, 1874.
Biela's	6617 "	May, 1872.
Faye's	744 "	June, 1873.
Vestphal's	678 "	1920.
De Vico's	7325 "	1919.
Brorsen's	75 "	1922.
Halley's	7678 "	1912.

There are many others whose periods and dates have been calculated, but some need confirmation. As some of these latter closely agree in period, it has been conjectured that they have originally formed part of one large comet, which divided in a similar way to Biela's.

Shooting Stars : Meteorites.

We shall on a clear night be almost certain to see falling or shooting stars. These are much more common at certain seasons of the year than at others, but scarcely a night passes without some being visible. For a long period there appears to have been little or no notice taken of them by astronomers, it being believed that they owed their origin merely to gaseous exhalations from the earth, which became ignited in the atmosphere. But it was found that at some times the number seen was immensely greater than at others, and instances are recorded in which they outnumbered the ordinary stars, so that the display was termed a star or meteoric shower. Humboldt speaks of one of these witnessed by his companion and him on the morning of the 12th Nov. 1799, when they were travelling in South America, and says: "Towards morning a very extraordinary display of luminous meteors was observed in the East by M. Bonpland. Thousands of bolides and falling stars succeeded each other during four hours, having a direction from north to south, and filling a space of the sky extending from the east 30° on either side." On the 13th of November, 1831, another grand meteoric shower was witnessed which was followed by others on the same date in 1832 and 1833. The last of these seems to have been the most brilliant and splendid that has been recorded. It was observed with peculiar effect in some of the cities of the United States. The whole of the sky appeared to be on fire, and in many places the utmost terror and alarm was caused by the sight. Thus writes one of the papers of that date in the Eastern States: "From a point in the heavens about 15° south-easterly from our zenith the meteors darted to the horizon in every point of the compass. Their paths were described

in curve lines similar to those of the circles of longitude on an artificial globe. They were generally short in their course, resembling much an interrupted line — — — — thus. They ceased to appear when within 10° of the horizon. I did not see a single meteor pass the meteoric pole I have described, nor one pass in a horizontal direction. Several of them afforded as much light as faint lightning. One in the north-east was heard to explode with a sound like that of the rush of the distant sky-rocket. Millions of these meteors must have been darted in this shower. The singularity of this meteoric shower consisted in the countless numbers of the celestial rockets, and more especially in their constant uniform divergence from near the zenith."

The annexed cut represents the appearance of these meteors for several hours as seen at Boston, New York, Philadelphia, and other places in the eastern parts of the United States. It is copied from one of the periodicals published in the Eastern States about the time when these phenomena appeared.

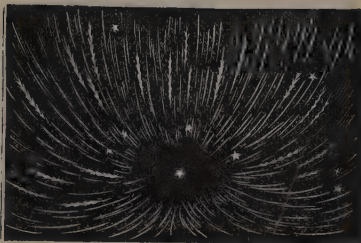


Fig. 129.

Another observer wrote: "The scene was truly awful, for never did rain fall much thicker than the meteors fell toward the earth." Many of the meteors were observed to leave behind them luminous trains, which were visible for a greater or less period. These have obtained the name of the November meteors, from the fact that at this period especially they fell in great numbers on three consecutive years. One remarkable fact was observed during the shower, and this was, that all the shooting stars appeared to radiate from a single point in the constellation Leo. According to the concurrent testimony of the observers this radiant point was stationary among the stars during the whole period of observation, that is, it did not move along with the earth in its diurnal revolution eastward—which tends to show the elevation of the meteors to have been beyond our atmosphere. Continued observations have shown that in the month of November there is always a much greater display of these bodies than at other times of the year. By examining likewise the records of these showers it was noticed that the grand displays seem to take place about every thirty-three years, sometimes have been seen for two or three consecutive years. It was accordingly suggested that not improbably a brilliant display might be seen in 1866, and though the numbers seen were not nearly so great as in 1833, the display was very grand and beautiful, so that those who watched through the night felt amply repaid for their trouble. Nearly all, as in previous

instances, appeared to radiate from the stars in Leo, and close to this spot many faint ones were seen, some seeming just to appear and vanish again, without having changed their position perceptibly. These were evidently travelling directly towards the earth, and hence their trains were so foreshortened as to be invisible.

These then are the main facts in connection with the phenomena of these meteors; and our task now is to find what we are to learn from them as to the nature and movements of these bodies. As we have observed, several facts seem to show that they had their origin beyond the surface of the earth; and the annual periodicity, it is supposed, may indicate that in certain parts of its orbit the earth is passing through a portion of space which is especially crowded with them. By noting the position of the spot whence they appear to radiate we learn the direction whence they are coming, and we find that the earth seems actually to be in the midst of a stream of them. There is an opinion now prevailing that there is a *ring* of those bodies revolving round the sun. This ring is about the dimensions of the orbit of the earth; it is inclined to the plane of the ecliptic at an angle of about 17° , cutting it just in the part in which the earth is situated on the 13th of November, so that at this period the earth is just passing through the ring. When the earth then at this time meets the stream of meteors they will, of course, seem to radiate from one point. Their uneven distribution in the stream may account for their constant fluctuation in number, and at any period they will only be visible at that part of the earth which is directed toward them. This explanation is, however, not deemed sufficient to account for the star shower being so much more brilliant one year than another, nor for the periodical interval of 33 years. It is thought moreover that, if we suppose that in one part of the ring they are clustered together more thickly than in the rest of it—that there is, in fact, in one part, a rich assemblage of these bodies, and that this group revolves in its orbit in about eleven days less than the earth does,—the whole will be explained. This assemblage, it is thought, extends over some small portion of the ring, so that at times the earth may for two or three successive years pass through or near the dense portion. It gains about 12° annually, so that for some thirty years the earth only passes through the portion where they are less crowded. Thus, in the figure, we suppose the dotted lines to represent the zone of meteorites distributed unevenly, but still for the most part kept within narrow limits. These are moving along from left to right. About the 13th of November the earth is moving along the part A B of its orbit in the direction indicated by the small arrows. It, therefore, meets the stream of meteors, which will, of course, all appear to radiate from one point. Their constant fluctu-

ations in number will be accounted for by their uneven distribution in the ring; and at any period they will only be visible to that part of the earth which is directed towards them.

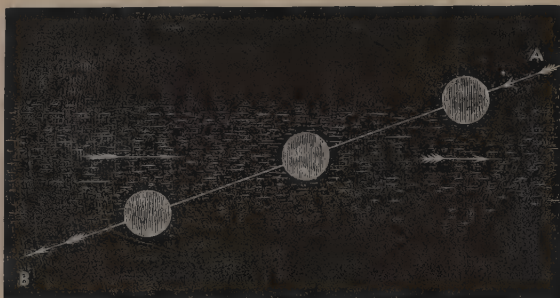


Fig. 130.

Besides the 13th of November there are other periods at which large numbers of these bodies are seen. The 9th to 11th of August is such a period; and though the numbers then seen are usually less than in November, the display is more certain and more uniform. There appear to be several of these rings of meteorites through which the earth passes at different periods; and a considerable number of radiant centres from which they diverge have been noted. Some astronomers suppose that the August and November meteors are parts of the same ring, which therefore cuts the earth's orbit in two points. The opinion that they are two separate rings is, however, more generally received. M. Arago, the French astronomer, is of opinion that we cannot account for such extraordinary phenomena unless we suppose that beside the planetary bodies which revolve around the sun there are myriads of smaller bodies, which only become visible at the moment when they come within our atmosphere, and assume a meteoric appearance; and that they move in groups and also singly; all of which opinions are in support of the "ring theory." Dr. Olmsted, of Yale College, who particularly investigated the meteoric showers of 1833, deduces the following among other conclusions: *that* the distance of the body whence they emanated was about 2238 miles; that they entered the earth's atmosphere with a velocity of four miles per second; *that* some of the larger meteors must have been bodies of great size, not less than a mile in diameter; and *that* they consisted of portions of a nebulous body which revolves around the sun in 182 days; all of which is in favor of the "ring theory."

As to the nature or constitution of these bodies not much yet is known. It is believed, however, that they are for the most part small solid bodies revolving round the sun as already described. If

they are moving in a contrary direction to the earth, the velocity with which they enter the earth's atmosphere must be very great. The resistance of the air soon checks this motion, but by the friction thus produced the body is so intensely heated that it becomes luminous, and ultimately is entirely consumed. The average height at which they become visible is seventy miles, and their course is about thirty miles. The weight of most of them is believed to be very small, possibly not more than a few grains. There are, however, a few which are much larger, and owing to their size pass unconsumed through the atmosphere, and fall to the earth's surface. These are usually distinguished as *meteorites*, and are sometimes divided into aerolites or meteoric stones, aerosiderites, or pieces of meteoric iron. It is not known whether these bodies, like those already described, move in elliptical orbits, though it has been observed that they too are somewhat periodical.

The fall of many of these have been recorded, and in many instances the masses themselves are carefully preserved. When the body has been seen to fall a loud report has frequently been heard, accompanying it, and sometimes fragments have been scattered over a large area, indicating that while falling the meteorite exploded. Mr. Barham relates that when riding in Jamaica one evening, he beheld a ball of fire apparently about the bigness of a bomb swiftly falling down with a great blaze. Approaching the place where it fell he found the ground strangely broken up, and ploughed, and several holes appeared of the bigness of a man's head, and all the green herbage burned up near the holes; at the same time he experienced a strong smell of sulphur.

In the year 1676 a great globe of fire was seen at Bononia, in Italy, about forty minutes after sunset. It passed with a rapid course, at the rate of not less than 160 miles a minute, and at last stood over the Adriatic Sea. It crossed all Italy in its course, and on computation it was found that it could not have been less than thirty-eight miles above the earth's surface. Wherever it approached, the inhabitants below could distinctly hear it with a hissing noise resembling that of a firework. It was heard to go off with a violent explosion. Its magnitude, when over Bononia, appeared twice as long as the moon one way and about as broad the other. It was estimated to be a mile long, and about half a mile broad. One of the most striking and extraordinary of this kind of meteors made its appearance in Britain on the 18th of August, 1783, about nine o'clock in the evening. It was seen in all parts of the island, from the Shetland Isles to the English Channel, over all France, and a great part of Italy, and is supposed to have described a track of at least 1000 miles over the surface of the earth. It appeared to have burst

and re-united several times, and the first bursting which was noticed was somewhere over Lincolnshire, in England. Its appearance created universal wonder and alarm. When it was observed at Brussels the moon appeared quite red, and the illumination was so great as totally to obliterate the stars. A report was heard some time after it disappeared, which was very loud in the South-eastern counties of England. A hissing sound was said also to accompany its progress. At Greenwich two bright balls, parallel to one another, led the way, and were followed by the expulsion of eight others. The balls seemed tinted first with a pure bright light, then followed a yellow, mixed with azure, red and green, which, with a coalition of bolder tints, and a reflection from the other balls, gave the most beautiful rotundity and variation of color with which the eye could be charmed. The height of this fire-ball was reckoned at from seventy to ninety miles; its diameter was estimated at nearly two miles, and its velocity at 1000 miles a minute. The same year, on October 4th, at forty-three minutes past six in the evening, another meteor appeared nearly of the same description, but much smaller and of shorter duration. It was first perceived to the northward, as a stream of fire, like the common shooting stars, but large; and presently burst out into that intensely bright bluish flame, which is peculiar to such meteors. It was nearly globular, but left behind it a dusky red streak of fire. After moving ten degrees in this state it became suddenly extinct without any explosion. Its height was estimated at between forty and fifty miles. The celebrated Gassendi relates that a meteor fell at Vaison, in France, of the size and shape of the human head; it was mainly composed of iron. In April, 1803, a brilliant fire-ball was seen in Normandy, travelling very rapidly; shortly after which a loud explosion was heard, and a great number of pieces of stone fell to the ground, nearly 3,000 being collected. When picked up soon after they have fallen these bodies are usually found to be intensely hot. On chemical examination no new elements have been discovered in them but such as are known to be distributed throughout the earth's crust. These are fifteen in number, namely, iron, nickel, cobalt, manganese, chromium, copper, arsenic, zinc, potash, soda, sulphur, phosphorus, carbon, &c., constituting altogether nearly one third of all the known simple bodies.

Some of these meteors, especially the large fiery ones, doubtless owe their origin to gaseous exhalations from the earth, which, assuming different forms in the atmosphere, under a variety of combination, descend to the earth again with the manifestation of light; and, as for the rest (the star showers), the theory of small bodies revolving round the sun in an orbit which intersects the plane of the earth's orbit, whence they would come within the sphere of the earth's

attraction, does not appear unreasonable, and may be sufficient to account for their appearance. The idea of any of the heavenly bodies, by explosive action of any internal or external force, sending any of their constituent parts beyond their spheres of attraction, appears as unreasonable as it does impossible.

The Aurora Borealis, or Northern Lights.

For beauty there is none of the luminous meteors that surpass the Aurora Borealis or Northern Lights. This is not unfrequently seen in our latitudes, but less frequently and with far less splendor than it appears in the polar regions. Its form varies greatly; when perfectly developed, an arch of light appears to cross the sky a little way above the horizon, and from this, quivering streamers dart upward



Fig. 131.—THE AURORA BOREALIS OR NORTHERN LIGHTS.

continually towards the zenith, giving rise to the name of “the merry dancers,” by which this phenomenon is sometimes known. Frequently several auroral arches are seen at once, and the effect is then very grand and sublime. At other times the streamers appear to shoot up from behind distant hills. It has also been known to assume the form of a huge curtain suspended in massive folds, which reflect various colors. The Aurora in our latitudes appears almost always far less distinct and perfect than any of these; at times its ruddy glow has been mistaken for that of a distant fire.

Various hypotheses have been started to account for these appearances. The fluctuations of the magnetic needle, which occur during

their continuance, indicate strongly an electrical origin; and this is further confirmed by the fact that telegraphic messages have been interrupted and the alarms rung by the auroral currents. Humboldt says: "The bold conjecture hazarded, one hundred and twenty-eight years since, by Halley, that the Aurora Borealis was a magnetic phenomenon, has acquired empirical certainty from Faraday's brilliant discovery of the evolution of light by magnetic forces. The northern light is preceded by premonitory signs. Thus, in the morning before the occurrence of the phenomenon, the irregular horary course of the magnetic needle generally indicates a disturbance of the equilibrium in the distribution of terrestrial magnetism. When this disturbance attains a great degree of intensity the equilibrium of the distribution is restored by a discharge attended by a development of light. The Aurora itself is therefore not to be regarded as an externally manifested cause of this disturbance, but rather as a result of telluric activity, manifested on the one side by the appearance of the light, and on the other by the vibrations of the magnetic needle." "This phenomenon derives the greater part of its importance from the fact that the earth becomes *self-luminous*, and, that as a planet, besides the light which it receives from the central body, the sun, it shows itself capable in itself of developing light. Occasionally, as on the 7th of January, 1831, the intensity of the terrestrial light is so great that printed characters can be read without difficulty." Earth currents are much stronger during the continuance of the Aurora, and hence this phenomenon is now generally attributed to the discharge of electricity into the upper regions of the air, in effecting a restoration of a disturbed condition of equilibrium.

The Mariner's Lights.

The Mariner's Lights, sometimes called St. Elmo's Fire, is another of the electrical meteors. A bright flame-like light is seen at the top of the masts and sometimes at the ends of the spars. This flame often points towards an approaching cloud, increases in length as the cloud passes over it; at times it has been seen as much as two or three feet long. The appearance is easily accounted for, and a good illustration of the same effect is seen by holding a sharp point near the conductor of an electrical machine. The electricity from the cloud, instead of passing off in the form of a flash of lightning, is in this way silently carried off by induction. In mountainous regions travellers have occasionally noticed a somewhat similar appearance at the end of their sticks or umbrellas, and a faint hissing sound usually accompanies it. The air in this case is highly electrical; and the pointed ends of the sticks have served to attract the fluid

and discharge it. Both the Aurora and the Mariner's Lights are merely manifestations, as light, of a substance which we may call electricity.

THE FIXED STARS.

Let us now turn our attention for a little from the solar system to the fixed stars which appear in such vast profusion in the sky; and before we begin to contemplate these remote luminaries it may be well for the reader to form some idea of the distances at which they are from us, and as to the magnitudes of some of them. Great as the sun and his surrounding planets are, they dwindle into a point when we wing our way to the regions of the stars. Before we could arrive at the *nearest* star that is visible from our globe, we behooved to pass over a space of at least twenty billions of miles in extent, a space which a cannon-ball, flying with its utmost velocity, would not pass over in less than *four millions of years*. Here every eye on a clear winter's night may behold a thousand shining orbs, most of them emitting their splendor from spaces immeasurably distant; and bodies visible to us at such distances must necessarily be of immense magnitudes. There is reason to believe that the least twinkling stars which our eyes can discern is not less than the sun in magnitude and splendor; and that many of them are a hundred or even a thousand times superior in magnitude to that stupendous luminary. Sir W. Herschel, when speaking in reference to Dr. Wollaston's photometrical experiments on the light of Sirius (the brightest star), says, "Dr. Wollaston's assuming, as we think he was perfectly justified in doing, a much lower limit of possible parallax in Sirius than we adopted in the text, has concluded the intrinsic light of Sirius to be *nearly that of fourteen suns*." Sir W. Herschel informs us that with a magnifying power of 6450, and by means of his new micrometer, he found the apparent diameter of *Vega* or a *Lyrae* to be 0'.355; this will give the real diameter of the star about 38 times that of the sun, or 33,440,000 miles, supposing its parallax to be one second. Were this its true estimate its solid contents would be 19,579,357,857,382,400,000,000, or above nineteen thousand, five hundred and seventy-nine trillions of cubic miles; which is fifty-four thousand, eight hundred and seventy-two times larger than the solid contents of the sun.

It is very difficult from mere inspection to form any estimate of the number of these bodies; it appears, however, from catalogues which have been compiled, that the total number of stars visible to the naked eye is about 6000. One half of the sky only can be seen at one time, and the number visible on a clear night may therefore be set down approximately at 3,000. These stars vary greatly in bri-

liancy and apparent size, and have accordingly been divided into six classes, the brightest being classed as of the first magnitude, while the faintest visible to the naked eye are set down as of the sixth; the rest being divided into the intermediate four magnitudes. As a general rule it is computed that stars of the first magnitude are about 100 times as brilliant as those of the sixth. The light of Sirius is estimated, however, to be equal to that of 324 of the latter. Though the number of stars seen by the naked eye is thus limited, it must not be supposed that these are all that exist. If we direct a telescope to any part of the sky we shall at once perceive that the field of view is covered with points of light, and the number of these telescopic stars is found to be infinitely greater than that of those visible to the naked eye. These telescopic stars are classed into magnitudes down to the fifteenth and sixteenth, or even lower, according to the power of the telescope employed for bringing them into view. The stars are especially numerous in the regions of the Milky Way, that starry belt that encircles the sky, with which every common observer is familiar. The ancients seem to have believed that the brightness of this zone was owing to a confluence of stars, for Ovid writes: "Its groundwork is of stars."

Soon after the invention of the telescope, when astronomers were enabled to penetrate the stellar regions, they were astonished at the number of stars that appeared in this shining zone of the heavens; and their numbers appeared to increase in proportion to the magnifying powers of their telescopes. It was not, however, till Sir W. Herschel applied his powerful instruments to this region of the heavens that its profundities were explored, and all its minute nebulous parts shown to consist of countless myriads of stars of every apparent magnitude stretching on to infinity, until they appeared to be lost to the eye, even when it was assisted by the largest telescopes. In several fields of view of this zone, occupying a space not much more than twice the breadth of the moon, one perceives through a good telescope more of those twinkling luminaries than all the stars visible to the naked eye throughout the whole canopy of heaven. In certain places in it, every slight motion of the telescope presents new groups and new configurations; and the diversified and wondrous scene is continued over many degrees in succession. The variety and the beautiful configurations of the stars strikes the observer with amazement, and makes him feel as if he were lost in penetrating the immensity of the universe. Sir W. Herschel explored this region of the heavens with a Newtonian reflecting telescope of twenty feet focal length, and an aperture of eighteen inches. He found that this telescope completely *resolved all the whitish appearances into stars*, which the telescopes he formerly used had not light enough to do.

The portion he first observed was that about the hand and club of Orion; and he found in this place an astonishing number of stars, the number of which he endeavored to estimate by counting many fields; that is, the apparent spaces in the heavens he could see at once through his telescope, without moving it, and computing from a mean of these the number that may be contained in a given portion of the Milky Way. In the most vacant space to be met with in that region he found 63 stars; other six fields contained 100, 60, 70, 90, 70, and 74 stars; a mean of all which give 79 for the number of stars in each field; and then he found that by allowing 15' for the diameter of his field of view, a belt of 15° long and 2° broad, which he had often seen pass through his telescope in an hour's time, could not contain less than 50,000 stars, large enough to be distinctly enumerated; beside which he suspected twice as many more which he could see only now and then by faint glimpses for want of sufficient light. The reader may remember that these stars extended onwards to infinity, that is, that there is *no end* to them in that one or in any direction,* and the small place occupied by those now mentioned is only the $\frac{1}{4375}$ th part of the visible canopy of the heavens; so that if every part of the firmament were equally rich in stars, there would be *within the reach* of such a telescope as Herschel's no less than sixty-eight millions seven hundred and fifty thousand stars. And it may be further considered that it was only in the comparatively "vacant spaces" of this zone that the number of stars stated above were perceived.

In exploring some other parts of the zone, Sir W. Herschel informs us that he descried a much greater number of these luminaries in a similar extent of space. "In the most crowded parts of the "Milky Way," he says, "I have had fields of view that contained no fewer than 588 stars, and these were continued for many minutes, so that in one quarter of an hour's time there passed no less than 116,000 stars through the field of view of my telescope." In order to understand this description, we are to understand the telescope to have been fixed in one position at the time of observation; and that, by the diurnal motion of the earth, or the apparent motion of the heavens, the first field of stars gradually passed out of view, and other fields appeared in succession; until, in the space of fifteen minutes of time, one hundred and sixteen thousand stars passed over the field of vision. Now the field of view taken in by the telescope was only 15' of a degree, less than the one-half of the apparent size of the moon. In this narrow field were seen about as many stars as

* Some theologians appear to understand the material universe as limited; but there is no reason to conclude that what we understand as matter in its various forms is not infinite. It is quite as easy to conceive of matter infinite as to conceive of pure space devoid of all matter existing infinitely outside of and beyond all matter.

observers generally behold throughout the whole firmament by the naked eye in a clear winter's night. At another time, this indefatigable astronomer perceived no less than 258,000 stars pass before his view in the course of forty-one minutes. In the space between β (Beta) and γ (Gamma) of the Swan the stars are found clustering with a kind of division between them, so that they may be considered as clustering towards two different regions. In this space, taking an average breadth of about 5° , he found from observation that it contains more than 331,000 stars, which gives above one hundred and sixty-five thousand for each clustering collection. If we suppose every part of this starry belt equally full of stars as this space now referred to, it will contain no less than 20,191,000 stars; for, supposing the Milky Way to be, on an average, 12° broad, the whole of it will contain an area of $4320 = 12^\circ \times 360^\circ$, for this belt extends clear round the heavens. Now if the space examined by Herschel between Beta and Gamma of the Swan be about 14° in length, and 5° in breadth, it will contain an area of 70° , which is somewhat less than the $\frac{1}{61}$ st part of the space occupied by the Milky Way. The whole visible heavens considered as a concave spherical plane contains an area of $41,253^\circ$. Now, could we suppose every portion of the firmament to be equally well replenished with stars as the Milky Way, there would be more than 195,000,000, or more than one hundred and ninety-five millions of stars in the heavens *discernible* by such a telescope as that of Herschel; but as there are comparatively few other regions of the heavens which are open to our view so densely crowded with stars as the Milky Zone, we must make a certain reduction from this estimate of *discernible* stars, though it is most probable there are more than one hundred millions of stars within the reach of our best telescopes, were all the spaces of our firmament moderately well explored; and future generations with more perfect instruments will probably add indefinitely to the number. Had we taken the most crowded field of stars which Herschel perceived through his telescope, namely, 588, as our standard for estimating their number, the number of stars on the Milky Way would have been forty millions, and in the whole firmament three hundred and eighty-eight millions. In short, to use the words of Sir John Herschel: "This remarkable belt when examined through powerful telescopes, *is found* (wonderful to relate!) *to consist entirely of stars scattered by millions like glittering dust on the black ground of the general heavens.*" Now in regard to the distances of some of these discernible stars, we may easily conceive that they are immense, and far beyond our distinct comprehension. Sir W. Herschel, in endeavoring to determine a "sounding line," as he terms it, to fathom the depth of the stratum of stars in the Milky

Way, undertakes to prove by pretty conclusive reasoning, that his *twenty-feet* telescope penetrated to distances not less than 497 times the distance of Sirius; so that a stratum of stars amounting to 497 in thickness, each of them as far distant from each other in a direct line beyond Sirius as the star Sirius is distant from our sun, was within the reach of his vision, when looking through that telescope. Now, the least distance at which we can conceive Sirius to be distant from the earth or sun is 20,000,000,000,000 or twenty billions of miles, and consequently the most distant stars visible in his telescope must be four hundred and ninety-seven times this distance, that is, 9,940,000,000,000,000, or nearly ten thousand billions of miles. Such immense distances are already infinitely beyond the power of our conception; a cannon-ball moving at the rate of 500 miles an hour would occupy more than 2,267,855,068, or two thousand two hundred and sixty-seven millions, eight hundred and fifty-five thousand years in traversing that amazing interval.

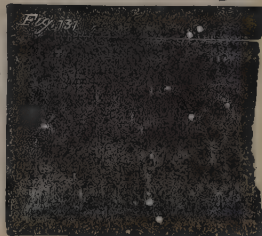
On our first excursion into the celestial regions we are almost terrified at the idea of the distance of Saturn, which a cannon-ball projected from the earth and flying with its utmost velocity, would not reach in 180 years. We are astonished at the size of such globe as Jupiter, which could contain within its circumference over thirteen hundred globes of the size of the earth. We are justly amazed at the stupendous magnitude of the sun, which is more than a thousand times the size of Jupiter, and which illuminates with its splendor a sphere of more than five thousand millions of miles in circumference. But what are all such distances and dimensions, vast and amazing as they are, when compared with the astounding grandeur of the scene before us? They sink into comparative insignificance, and are almost lost sight of amidst the myriads of splendid suns which occupy the profundities of the Milky Way. What is one sun and one planetary system in the presence of ten millions of suns, perhaps immensely more resplendent, and vastly more magnificent; and of hundreds of times this number of spacious worlds, which beyond all doubt revolve around them! Yet this scene, stupendous as it is, is not the universe. It is indeed only a comparatively small corner of it, which beings at an immensely greater distance will behold as an obscure and scarcely discernible spot on the outskirts of their firmament, and infinite numbers will not be able to behold at all, being situated at infinite distances from it. So that amidst this vast assemblage of material existence we may say in the language of the prophet, when speaking of the Almighty: "Even here is but the hiding of His power." Now what is man and the globe on which he dwells, amidst this sublime scene of immensity and magnificence! An atom in the infinite space, an infinitely small

particle of vapor compared to the ocean, a being who in respect to the magnificence of the universe and the grandeur of his Creator, is as nothing, and is counted to Him as less than nothing, and vanity.

Double Stars.

When we observe the heavens on a clear night we see here and there two stars in very close proximity ; the telescope further reveals to us the fact that very many of those which appear to the naked eye as single stars consist in reality of two or more so close together that they appear as one. Sir W. Herschel was the first to direct special attention to these, of which he compiled a list. He hoped that by accurate measurements of the apparent distance between them, he might be able in some instance to detect a variation, and thus ascertain their parallax, and by this their distances. The idea, then, was that these stars merely appeared close together because they happened to be in a straight line directed almost towards the earth ; that they were in fact merely optical couples, one being at an immense distance behind the other. After long-continued observation, Herschel found that their distances and relative positions did vary, but instead of it being as he expected, an annual fluctuation caused by the earth's motion, it was a progressive change. He thus found that in some cases the stars were revolving round one another in elliptic orbits, and they were physical couples, the two forming one system. These he called binary stars, or couples, to distinguish them from optical pairs. Other observers have followed up these investigations, and there are now upwards of 600 binary stars known and noted, and in many cases their times of revolution are thought to have been calculated. Of course these results will have to remain subject to future modifications, for we know that, considering the immense distances of the stars, accuracy in these respects can only be approximated to.

One of the best examples of double stars is afforded by ϵ Lyrae, which is sometimes called the double star. To the naked eye it appears a somewhat faint star, but a telescope of very moderate power will show it to be double. But when a more powerful instrument is employed, each of these components is in turn found to consist of two smaller ones. The lower pair, it is said, revolves in about 2000 years and the upper in about half that time, while the two couples take a very long period to revolve around their common centre of gravity. See the annexed figure. It is but lately that the attention of astronomers has been directed to such observations ; and on account of the very minute distances of the revolving stars from each other, and the slight variations in the angle of po-



sition which can be traced for a series of years, an age or two is requisite in order to determine with precision the degree of progress of their revolutionary movements. In the course of time, and by means of improvement in optical instruments, we may believe many important discoveries will be made in reference to the bodies in question, and that what is at present doubtful and obscure will be rendered definite and precise. But as the most powerful instruments which can be invented can carry our view only a very small distance comparatively beyond the outward boundaries of those mighty visible heavens which surround us, millions of those systems may still exist in those remote regions which will forever remain inexplorable by the inhabitants of earth.

Colored Stars.

One remarkable feature in connection with those binary stars is the fact that in some instances the component stars are of different colors. In ρ Leporis, for example, one is white, while the other is deep red. In β Cygni, again, the colors are yellow and blue. And in γ Andromedæ they are orange and green. "Many of the double stars," Sir John Herschel remarks, "exhibit the beautiful and curious phenomena of contrasted or complementary colors. In such instances the larger one is usually of a ruddy or orange hue, while the smaller one appears blue or green; probably in virtue of that general law of optics which provides that when the retina is under the influence of excitement by any bright-colored light, feebler lights, which seen alone would produce no sensation but of whiteness, shall for the time appear colored with the tint complementary to that of the brighter. Thus a yellow color predominating in the light of the brighter star, that of the less bright one in the same field of view will appear blue; while, if the tint of the brighter star verge to crimson, that of the other will exhibit a tendency to green, or even appear as a vivid green under favorable circumstances. The former contrast is beautifully exhibited by *Iota Cancri*, the latter by *Gamma Andromedæ*, both fine double stars. If, however, the colored star be much the less bright of the two it will not materially affect the other. Thus, for instance, *Eta Cassiopeiæ* exhibits the beautiful combination of a large white star and a small one of a rich ruddy purple. It is by no means, however, intended to say that in all such cases one of the colors is a mere effect of contrast; and it may be easier suggested in words than conceived in imagination what variety of illumination two suns, a red and a green, or a yellow and a blue one, must afford a planet circulating about either, and what charming contrasts and grateful vicissitudes, a red and green day, for instance, alternating with a white one and with

darkness, might arise from the presence or absence of one or other or both above the horizon. Insulated stars of a red color almost as deep as that of blood, occur in many parts of the heavens, but no green or blue star of any decided hue has we believe ever been noticed unassociated with a companion brighter than itself." This variety of colors in the double stars arises doubtless for the most part, if not altogether, from complementary colors; and as to the stars that appear insulated, and exhibit a rare color, we know there are different degrees of whiteness in light; the light of a candle, for example, or that which arises from the incandescence of some of the elementary substances is not as clear a white as the solar light; and, further, when we come to note the color of different stars, and compare it with former records, we find that in a few instances a change has taken place. Thus, Sirius, which now shines with a pure bright light, is spoken of by old observers as a ruddy star. There are also many others which exhibit changes in brilliancy; and these changes seem in most cases to be periodical. The star on which this discovery was made is *Omicron Ceti*, called also *Mira*, or the wonderful star, a name that is very appropriately given to it. At the time of its greatest brightness it is usually of the first or second magnitude, it then decreases for two or three months till it becomes invisible, and remains so for about five months, its minimum brightness being about equal to that of a star of the twelfth magnitude. It then again appears, and the whole period occupied in these changes is about 331 days. *Algol* or *Beta Persei* is another variable star, remarkable for its short period and rapid changes. It ordinarily appears a star of the second magnitude, but in a period of three and a-half hours it diminishes in brightness to the fourth magnitude, and after a few minutes begins again to increase, and attains its former brilliancy in another period of three and a-half hours. At this it remains two days, thirteen hours, and then the same series of changes recurs.

As to the mode of classification of the stars into magnitudes, &c.

We have mentioned that the telescopic stars are classed into magnitudes, according to their apparent brightness through the telescope. The question naturally suggests itself whether these different degrees of brightness result from differences in the size of the stars, or in their distances. To this it cannot be answered with certainty, as there are only a few stars whose distances have been approximately measured. There appears, however, to be little doubt that the difference is chiefly in their distances. The distances of the stars are ascertained in the same manner as those of the sun

and planets, that is, by parallax. Instead, however, of taking two stations at different parts of the earth's surface, and having the distance of the earth's diameter or semi-diameter as a base line between them, the diameter of the earth's orbit is taken as a base line, which is 183,000,000 miles, the observations being taken at intervals of six months, or when the earth is in the two opposite points of her orbit. But even with this immense line the parallax is so small, that it can only be detected by the most careful observations, and accurate instruments. In no case has it been found to be greater than $1''$, and if this be its value the distance of the star must be 206,000 times as great as that of the sun. The parallax of about a dozen of stars is now believed to be ascertained, and is found to vary between $0.919''$ and $0.046''$. The star *Alpha Centauri* is the nearest to the earth, and its distance is estimated at 20,496,000,000,000 or twenty billions four hundred and ninety-six thousand millions of miles; while the average distance of stars of the first magnitude is probably three or four times as great as this. These figures, however, fail to convey to the mind any definite idea as to the real distances.

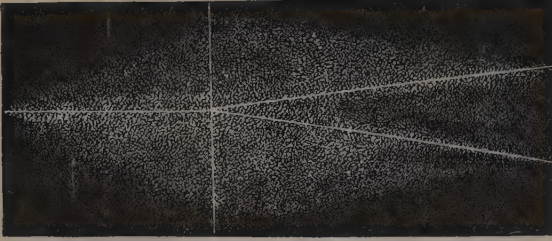
The heavens were divided by the ancients into twelve constellations or assemblages of stars, which they designated by different names, as before mentioned; and many new ones have been added to this number in modern times, so as to make in all 109. Several of these are, however, but small and unimportant, and hence are rejected by some astronomers. Special names, too, have been assigned to many of the most brilliant stars, but these have a tendency to confuse. In 1604 a German astronomer, named Bayer, published a celestial atlas, in which he designated the stars in each constellation by the letters of the Greek alphabet, the brightest being called α , the next β , and so on. This plan was found to answer so well that it has been continued to the present time. In some constellations, however, the number of stars now catalogued is so great that more letters are required to denote them; the English alphabet, therefore, follows the Greek; and if both prove insufficient the remaining stars are denoted by numbers. In a few instances in Bayer's catalogue the stars are not arranged quite in their order of brightness, either from want of accuracy in Bayer's observations, or from a change in the light of the star since his time; but it is considered better not to attempt to amend this, as it would only produce confusion. The best plan for one to follow who wishes to become acquainted with the different constellations is to study the sky itself with the aid of some maps, or of a celestial globe. Several of the constellations, as the Pleiades, the V-shaped Hyades; and Orion, with the three stars in the belt, commonly known as the

Yard Measure, also the great and the Little Bear and the Pole Star, are familiar to almost every one: these will serve as a guide in determining others.

As to the motions and position in space of the Sun and the solar system.

The stars are all of them bright, self-luminous bodies, like our sun, which, indeed, appears to other worlds to be one of the stars. Delicate observations show that they have proper motions, but it is very difficult and requires long-continued observations to determine them. We can, however, ascertain the motion of the sun by observing the relative distances of the stars. The stars in one part of the sky are seen gradually opening out, and getting further apart, while in the opposite quarter they are as gradually closing up; evidently showing that we are moving towards the former part of the heavens, just as when we are travelling in a forest the trees in front seem opening out, while those we have passed appear to be getting closer together. Now Sir W. Herschel found that the apparent proper motion of 44 stars out of 56 are very nearly in the direction which should result from a motion of the sun toward the constellation Hercules, or to a point of the heavens whose right ascension is $250^{\circ} 25\frac{1}{2}'$, and north declination $49^{\circ} 38'$. "No one," says Sir J. Herschel, "who reflects with due attention on the subject, will be inclined to deny the high probability, nay *certainly*, that the sun has a proper motion in some direction." If the sun then have a proper motion in space, as it appears probable it has, all the planets with their satellites, along with the comets, must partake of it; so that beside their own proper motions around this luminary, they likewise move along with the sun through the depths of infinite space with a velocity perhaps approaching to that with which they move around in their orbits. The earth will, therefore, partake of three motions, one around her circumference, one around the sun, and another in the direction in which the sun is moving; and consequently it appears probable we shall never again occupy that position in infinite space through which we are now passing.

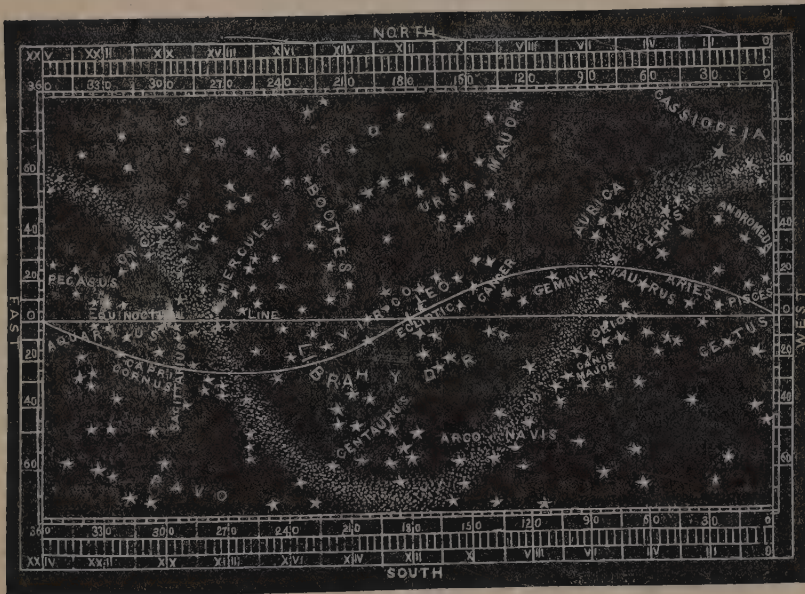
The sun, with his system of planets, &c., is found to occupy a position in a nebulae or cluster of stars, of which the Milky Way forms the main part. This Milky Way, in one part of its course around the celestial sphere, divides into two branches, which after separating a little way, and passing about a third around the sky, again unite into one. This may be illustrated by taking a flat circular body, as, for example, a cheese, and splitting it in the centre of the circumference, by passing a knife one-third of the way through,



SECTION OF THE MILKY WAY.

appearance of the Milky Way. Of course if the sun is moving through the regions of space, as it apparently is, though at a slow rate of motion compared with the orbital motions of the planets, all the other stars of this nebular cluster are also moving relatively

the two parts being made to diverge a little, as shown at *a*, *b* in the figure. The sun *s* is situated somewhere near the centre, and the split side causes the divided



MINIATURE MAP OF THE HEAVENS ON MERCATOR'S PROJECTION, SHOWING THE COURSE OF THE MILKY WAY.

for the fixed stars always maintain the same relative positions to each other. The sun with his system, doubtless, revolves in a cycle to which thousands of years are as nothing, in an elliptical or circular orbit, around some reciprocal centre of gravity.

Temporary Stars.

Closely allied to the variable stars are the new or temporary stars which have at times attracted much attention. Several appearances of such stars have been recorded; one of the most re-

markable is that observed by Tycho Brahe, in November, 1572. This star seems to have burst forth very suddenly, as it is said the constellation Cassiopeia, in which it appeared, had been carefully observed by an astronomer only two days before the star was seen, and that then no trace of it was observed. Also Tycho Brahe himself did not see it at half-past five when going from his house to his laboratory; but returning to his house about ten, he came to a crowd of country people who were staring at something behind him. Looking round he saw this wonderful object. It was so bright that his staff cast a shadow; it was of a dazzling white, with a little of a bluish tinge. It had no hair or tail around it, similar to comets, but shone with the same kind of lustre as the other fixed stars. It was even seen, by those who had good eyes, at noonday. Its phenomena, it is said, were so striking as to determine the celebrated Tycho Brahe to become an astronomer. This star continued visible for about sixteen months, gradually becoming fainter till it disappeared. In 945 and 1264 stars had appeared in the same constellation in a somewhat similar manner, and as the intervals between the three dates are almost equal, it has been conjectured that they might be three appearances of the same object. If this be the case, this star in the course of a few years (in 1891 or 1892, as thus its period would be about 319 years) may make its appearance again, and thus we might have an opportunity of gazing upon this object, which in former times attracted so much attention. Another temporary star of considerable brilliancy appeared in the year 1604, and was also carefully observed by Brahe. Modern times, however, have furnished us with several instances of this kind. In 1848 Mr. Hind observed a new star in Ophiuncus. It increased in brilliancy to the fourth magnitude, but subsequently decreased to the 11th or 12th, at which it now remains. In 1866 a new star appeared in the Northern crown, and was very minutely examined. It had been previously noted as of the sixth magnitude, but it suddenly shone out as a star of the second magnitude; its light, however, diminished very rapidly for some time. Attention was at once directed to it, the spectroscope being now available for observation. This instrument exhibited, in addition to the ordinary spectrum of the star, a second spectrum of bright lines, prominent among which were those indicative of burning hydrogen; so that it appears as if in this instance a sudden blaze was produced by incandescent hydrogen, and other substances.

When old star catalogues are compared with those of the present day, it is found that, in addition to many changes of magnitude, several stars, whose places are there recorded, are now no longer to

be seen ; and, on the other hand, that some of those now known are not recorded in the old lists, although their brilliancy is considerable, and would probably have insured their insertion had they been visible. In many other cases doubtless the discrepancy may have arisen from errors in observation ; but there is no doubt that many stars have altogether disappeared, and it is not improbable that some of these may be variable stars, which, after a more or less prolonged absence, may again become visible. Different explanations have been offered to account for these phenomena. Some imagine the star to revolve in an immense orbit, and that when it is visible it is in the part of that orbit nearest the earth, gradually increasing in brilliancy as it approaches to its nearest point, and gradually diminishing as it departs from it, which is not at all a reasonable supposition in the case of the stars. Some imagine the star to rotate, and one part of its surface to be more luminous than another, which appears a reasonable supposition ; others suppose that a planet of large dimensions may revolve around the star and thus eclipse its light, which may or not be a reasonable supposition ; but there is *no known* instance to us of a larger body revolving round a smaller one. If the telescope had been in use in the time of Brahe, he might have learned more about the star which he saw. Astronomers now are only waiting, in the hope that future researches, aided by the spectroscope and by more powerful and refined instruments, may throw fresh light on the whole subject. All the variable stars are being closely watched with this object in view.

CLUSTERS AND NEBULÆ.

Besides the stars and planets, we easily distinguish in the sky various groups called clusters or nebulæ. These are usually divided into *Irregular Groups*, more or less visible to the naked eye ; *Clusters*, resolvable by good telescopes ; and *Nebulæ*, many of which on account of their immense distance are irresolvable with the most powerful telescopes yet made. There are many examples of the first class, among which may be mentioned Præsepe or the Beehive, and the sword handle in Perseus, both of which are very beautiful telescopic objects. Very many objects of the second class have also been noted. In ordinary telescopes they appear for the most part as faint, cloudy masses ; but as more powerful instruments are directed to them they begin to resolve into stars, apparently placed very close together. Every increase yet made in the power of the telescope has had the effect of resolving more of these clusters. As to shape and appearance these objects vary greatly,

some being globular or elliptical masses, while others present very strange forms. The great nebula in Orion, and the Dumb-bell nebula in Vulpecula, are examples of this. See an illustration of



Fig. 132. THE GREAT NEBULA IN ORION.

the nebula in Orion in Figure 132; and of Dumb-bell Nebulæ Figures 133 and 134. Many, however, can only be partially resolved, parts of misty matter gradually fading away in the distance being distinguishable apart from the stars. No definite line can indeed be drawn to distinguish between clusters and nebulæ. So

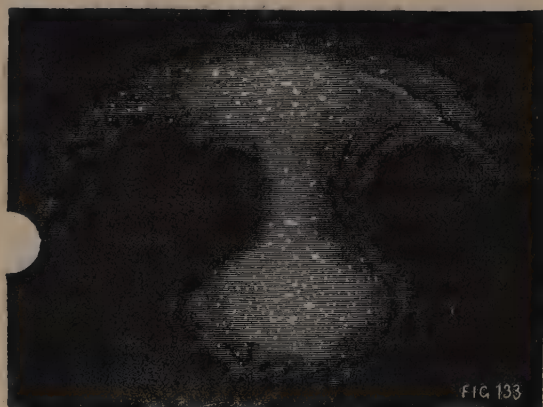


Fig. 133.

great is the number of these objects that a catalogue of them compiled by Sir J. Herschel contains no less than 5,079. As to their character and distance we may derive some information from the

observations of Sir W. Herschel. Most of the nebulæ yielded to the Newtonian reflector of twenty feet focal distance, and twelve inches aperture, which plainly discovered them to be composed of

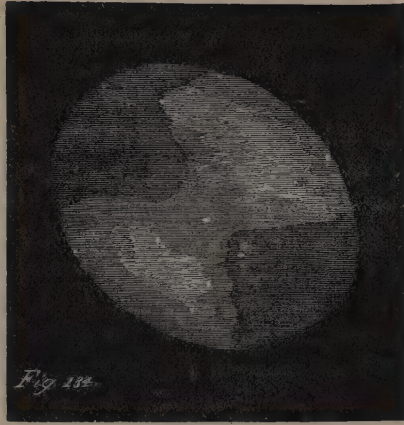


Fig. 134.

stars, or at least to contain stars, and show every other indication of their consisting of them entirely. "The nebulæ," says he, "are arranged into strata, and run on to a great length; and some of them I have been able to pursue, and to guess pretty well at their form and direction. It is probable enough that they may surround the whole starry sphere of the heavens, not unlike the Milky Way, which, undoubtedly, is nothing but a stratum of fixed stars. And as this latter immense starry bed is not of equal breadth or lustre in every part, nor runs on in one straight direction, but is curved and even divided into two streams along a very considerable portion of it, we may likewise expect the greatest variety in the strata of the clusters of the stars and nebulæ. One of these nebulous beds is so rich that in passing through a section of it in the time of only thirty-six minutes, I have detected no less than thirty-one nebulæ, all distinctly visible upon a fine blue sky. Their situation and shape, as well as condition, seem to denote the greatest variety imaginable. In another stratum, or perhaps a different branch of the former, I have seen double and treble nebulæ variously arranged; large ones with small seeming attendants; narrow but much extended lucid nebulæ, or bright dashes; some of the shape of a fan, resembling an electric brush issuing from a lucid point; others of the cometic shape, with a seeming nucleus in the centre, or like cloudy stars surrounded with a nebulous atmosphere. A different sort again contains a nebulosity of the milky kind, like that wonderful, inexplicable phenomenon about Theta Orionis; while others

shine with fainter mottled kind of light which denotes their being resolvable into stars." "In my late observations on nebulæ," says Sir W. Herschel, on another occasion, "I have found that I generally detected them in certain directions rather than in others; that the spaces preceding them were generally quite deprived of their stars, so as often to afford many fields without a single star in it; that the nebulæ generally appeared some time after among stars of a considerable size, and but seldom among very small stars; and when I came to one nebula I generally found several more in the neighborhood; that afterward a considerable time passed before I came to another parcel. These events being often repeated in different altitudes of my instrument, and some of them at considerable distances from each other, it occurred to me that the intermediate spaces between the sweeps might also contain nebulæ, and finding this to hold good more than once, I ventured to give notice to my assistant at the clock that I found myself on nebulous ground." The discoveries of the Herschels support the view that all the stars in the universe, so far at least as discernible by the telescope, are arranged into systems, which revolve round their respective centres; and that the stars are not dispersed at random in a kind of magnificent confusion through boundless space; and may likewise exist systematically in immense clusters throughout the regions of infinitude. Of course, we may certainly believe that each of these stars that appear in space or in the far distant nebulæ by the telescope, is itself, as our sun, the centre of a planetary system. The very object of a sun is to give light and heat to surrounding worlds, as well as to be their bond of attraction. All space is replenished at certain intervals with opaque globes, although they may never appear to our naked eye, nor yet happen within the view of our telescopes; the very idea of stable equilibrium in the universe teaches this; there is not a globe too many in one region of space, nor a globe less than enough in another region; nor does the law of gravitation allow us to suppose that even the smallest amount of matter can be in excess or in deficiency in the systems of the universe without having the universal order disarranged and the balance of equilibrium destroyed. If gravitation means anything it means this. Astronomers have descried the self-luminous globes, because they are of immense size and great brilliancy; but the investigation of opaque globes which exist in infinite numbers and of various sizes throughout space, and on which the sensitive and rational creatures of God exist, presents a noble field of labor for their eternal employment.

The nebulæ have great variety of forms; some are comparatively

bright, and others so obscure as to render it difficult to detect them in the field of view of the telescope, or to ascertain their shape. Some of them appear round, some oval, and others of a long elliptic shape ;



Fig. 135.

some exhibit an annular form like luminous rings, and others appear like an ellipsis with a dark space in the centre ; but the greater number approximate to a roundish form. Of the 103 nebulae inserted in Messier's catalogue eighteen were known at the time to consist of small stars ; but Sir W. Herschel afterward found twenty-six more of them to consist purely of clusters of stars, eighteen of small stars, accompanied with nebulosity, and the remainder not resolvable into stars by the highest powers of his telescope. But it is evident these objects, though apparently small and obscure, must be systems of immense magnitude, when we take into consideration the vast distances at which they must be situated from our globe. As to this point, Sir W. Herschel speaks as follows : " My opinion of their size is grounded on the following observations : There are many round nebulae of about five or six minutes in diameter, the stars of which I can see very distinctly ; and on comparing them with the visual ray calculated from some of my long gauges, I suppose by the appearances of the small stars in these gauges that the centres of these round nebulae may be 600 times the distance of Sirius from us." He then goes on to show that the stars in such nebulae are probably twice as much condensed as those of the cluster in which we are placed : otherwise the centre of it would not be less than 6000 times

the distance of Sirius ; and that it is possibly much underrated by supposing it only 600 times the distance of that star. "Some of these round nebulæ have others near them perfectly similar in form,



Fig. 136.

These in figures 135 and 136 are Specimens of Nebulæ of various descriptions: Dumb-bell nebulæ; nebulæ representing the cluster to which our system belongs; diffused nebulæ; and nebulous stars.

color, and the distribution of stars, but of only half the diameter ; and the stars in them seem to be doubly crowded, and only at about half the distance from each other. They are indeed so small as not to be visible without the utmost attention. I suppose these miniature nebulæ to be at double the distance from the first. An instance equally remarkable and instructive, is a case where, in the neighborhood of two such nebulæ as have been mentioned, I met with a third

similar resolvable, but much smaller and fainter, nebula. The stars of it are no longer to be perceived ; but a resemblance of color to the former two and its diminished size and light, may well permit us to place it at full twice the distance of the second, or about four or five times the distance of the first ; and yet the nebulosity is not of the milky kind, nor is it so much as difficultly resolvable or colorless. Now, in a few of the extended nebulae the light changes gradually, so as from the resolvable to approach the milky kind, which appears to me an indication that the milky light of nebulae is owing to their much greater distance. A nebula, therefore, whose light is perfectly milky, cannot well be supposed to be at less than six or eight thousand times the distance of Sirius ; and though the numbers here assumed are not to be taken otherwise than as very coarse estimates, yet an extended nebula which, in an oblique situation where it is possibly foreshortened by one-half, two-thirds, or three-fourths of its length, subtends a degree or more in diameter, cannot be otherwise than of wonderful magnitude, *and may well outvie our Milky Way in grandeur.*" It seems to be a very natural conclusion that the nebulae which are perfectly similar in form, color, and the distribution of stars, but of only half the diameter of the other, and the stars doubly crowded, are about double the distance from the first. And if the distance of the larger nebulae, whose stars are distinctly seen, be at least 600 times that of Sirius, as there seems reason to believe, then the distance of those which are only half the diameter must be 1200 times the distance of that star, that is, at the very least, 24,000,000,000,000,000, or twenty-four thousand billions of miles. But the nebulae whose light is "perfectly milky," or so far removed from us that the stars of which they are composed cannot be separately distinguished, may be reasonably considered as at seven thousand times the distance of Sirius, or in number 140,000,000,000,000,000, or one hundred and forty thousand billions of miles ; a distance indeed of which we cannot by any means form a distinct conception. A cannon-ball flying with its utmost velocity would require more than thirty-two thousand millions of years before it could move over an equal space. Since the distances of these nebulae are so immensely great, and since those that are nearest us are found by actual observation to be composed of countless numbers of stars, leaving us no room to doubt that the most distant are also immense systems of the same character, how vast must be the magnitude, and how inexpressible the grandeur, of the numerous luminaries of which they are made up ; and how immensely great the number of planetary bodies which revolve around them through boundless space !! From all the observations of Sir W. Herschel, he is of opinion that our Nebula,

or the Milky Way, as it may be termed, is not the most considerable within the range of vision ; and he points out some very remarkable nebulæ, which in his opinion cannot be less, but are probably *much larger*, than that of which our sun and system form a part.

Some idea of the extreme faintness of some of the distant nebulæ may be formed from the estimate which has been made that their light varies from $\frac{1}{1500}$ th to $\frac{1}{2000}$ th of that of a sperm candle a quarter of a mile distant. The nebulæ, as has been seen, are not distributed by any means uniformly over the surface of the sky, the greater number of them being situated in a zone crossing at right angles the Milky Way. In the constellation Virgo there is the greatest aggregation of them, one portion of it being known as the nebulous region of Virgo ; and in the southern hemisphere, nor far distant from the pole, are two brilliant cloud-like patches, called the Magellanic clouds, or Nubeculæ. These, when examined by the telescope, are found to be composed of stars, clusters, and nebulæ, collected together seemingly, but most probably in their order of distance. In appearance they somewhat resemble a portion of the Milky Way ; but they are quite distinct from it.

One of the most remarkable and extensive nebulæ in the heavens is that which is found in the constellation of Orion. In looking at that constellation, which makes a splendid appearance in the southern sky during the winter months, the first object which arrests one's attention is the three brilliant stars equidistant from each other in a straight line, which is called the belt of Orion. Immediately below these, hanging down as it were from the middle of the belt, three small stars at nearly equal distances are perceived, which are termed the sword of Orion. On directing the naked eye to the middle star of these three, the observer perceives something which has the appearance of a small star, but not well defined ; this is the great nebula of Orion, of which, however, one can form no definite conception without the aid of a good telescope. With a common pocket achromatic telescope, of a foot in length, the nebulosity may be plainly perceived ; but the higher the magnifying power, and the larger the aperture of the object-glass, the more brilliant and distinct does this phenomena appear, along with a number of small stars connected with it, which are quite invisible to the unassisted eye. Huygens was the first to discover this phenomena, and he gives the following description of it in his *Systema Saturnium* : “ Astronomers place three stars close to each other in the sword of Orion ; and when I viewed the middlemost with a telescope, in the year 1656, there appeared in the place of that one twelve other stars among these three, that almost touch each other, and four more beside appeared

twinkling as through a cloud, so that the space about them seemed much brighter than the rest of the heavens, which, appearing wholly blackish by reason of the fair weather, was seen as through a certain opening, through which one had a free view into another region which was more enlightened. I have frequently observed the same appearance in the same place without any alteration ; so that it is likely that this wonder, whatever it may be in itself, has been there from all time ; but I never took notice to anything like it among the rest of the fixed stars." The reader will easily recognize the description in the figure of this nebula here presented which has been obtained, however, by means of a more perfect telescope than any that were in use in the time of Huygens. The following is Sir J. Herschel's description of this phenomenon : " I know not how to describe it better than by comparing it with a curdling liquid, or a surface strewn over with flocks of wool, or the breaking up of a mackerel sky, when the clouds of which it consists begin to assume a curious appearance. It is not very unlike the mottling of the sun's disc, only, if I may so express myself, the grain is much coarser and the intervals darker, and the flocculi, instead of being generally round, are drawn into little wisps. They present, however, an appearance of having been composed of stars, and their aspect is altogether different from that of resolvable nebulae. In the latter we fancy by glimpses that we see stars, or that could we strain our sight a little more we could see them ; but the former suggests no idea of stars, but rather something quite distinct from them." It is calculated that this wonderful nebula would fill a space twenty-nine millions of times larger than that contained within the orbit of Uranus ; so that, compared with it, the whole solar system is but an imperceptible point. It is also calculated that there are many nebulae within the reach of the telescope which altogether surpass, in extent, in grandeur, and magnificence, the cluster to which our system belongs, or the Milky Way. And what of those that extend *in every direction in endless succession ! !*

Variable Nebulae.

Some of the nebulae, like some of the stars already referred to, are found to be variable. In October, 1852, Mr. Hind discovered a very small one with a star of the tenth magnitude near to it. This was afterwards observed, and its position noted, by other astronomers, but in 1861 it had entirely disappeared. Another nebula, which had frequently been observed as a well-defined compact cluster, was found in May, 1860, to be replaced by a seventh magnitude star.

After a few weeks the stellar appearance had ceased, and the cluster seemed to be resuming its usual form. The question as to the real constitution of the nebulæ is one which had given rise to much speculation. There is now little or no doubt expressed as to many of them being starry systems somewhat resembling our own cluster, but immensely removed from it. This belief rapidly gained ground as one after another of the nebulæ was resolved, by the application of more powerful telescopes; and it is very generally believed that all the telescopic nebulæ will ultimately be thus resolved. "It appears," says Humboldt, referring to Lord Rosse's Telescope, "from all the notices I have been able to collect from the works of distinguished astronomers long accustomed to the observation of nebulous spots, that out of a large number of nebulæ indiscriminately taken from among all the classes contained in the catalogue of 1833, and regarded as irresolvable, almost all have been perfectly resolved. Sir John Herschel maintains the same view as well in his opening address before the British Association at Cambridge in 1845 as in the *Outlines of Astronomy*, 1849, where he expresses himself as follows: "The magnificent reflecting telescope constructed by Lord Rosse, six feet in aperture, has resolved or rendered resolvable multitudes of nebulæ which had resisted all inferior powers. Although, therefore, nebulæ do exist which even in this powerful telescope appear *as* nebulæ without any sign of resolution, it may very reasonably be doubted whether there be really any essential physical distinction between nebulæ and clusters of stars." The hypothesis previously received was that the nebulæ consisted merely of masses of cloudlike matter. When the spectroscope was first directed to one of those objects, owing perhaps to the faintness of the light, no spectrum could be obtained, but merely a short luminous band. A second and third fainter bands were afterwards made out, and these lines were found to correspond with those indicative of nitrogen, hydrogen, and barium. These facts seem to point to the conclusion that the light emanated from incandescent gaseous matter.

The Nebular Hypothesis.

Before the invention of the telescope, and for some time after its invention, while it was yet comparatively imperfect, the nebulæ were supposed to be vast, formless masses of vapory matter scattered here and there throughout space. Hence arose the "nebular hypothesis," as it is termed, according to which the sun and our whole system of planets originally existed in the form of a mass of nebulous matter filling a space greatly exceeding that contained within

the orbit of Uranus. This vast mass the theory supposed was set in rotation, and, as it gradually cooled, became more and more condensed, until at length some part assumed the liquid form, and would then form a ring surrounding the central mass. This ring would, of course, be in rotation, and, as it would scarcely be of uniform thickness throughout, would soon break up; the matter composing it would then be collected into a ball still rotating round the centre, and at the same time revolving on its own axis. In this way the hypothesis had it that all the planets were in turn formed, and they, by centrifugal force, threw off their satellites and rings, till at length the system became complete, and the planets cooled down into solid masses.

Such is the "nebular hypothesis," and in it is seen what absurd and groundless theories ignorance gives rise to among men. It displays a singular deficiency, which is usually characteristic of myths, in that it neglects to account for the origin of comets, a large number of which have long been recognized as permanent members of our system, moving periodically in well defined orbits. Nor does it at all consist with the direction of the motion of the satellites of Uranus and Neptune being *retrograde* to that of all the other members of our system, if this be so; but some astronomers consider the opposition to be only apparent. With all the telescopic nebulae that have been resolved into stars, and with the fact patent that only distance prevents any of them from being thus resolved into stars and all other revolving bodies, men henceforth will have no need of forming such groundless theories with respect to an origin for the visible world; nor, with all the light which is now afforded them of its probable permanence, will people have an excuse for any more believing the groundless theories of hasty speculators with respect to it. The question of an origin or destiny of the cosmos they should leave to God, who only can know of such things, and be content with giving a proper attendance to their known duties.

SKETCH OF THE HISTORY OF ASTRONOMY.

We think it proper here, and of interest to our readers, to give them a sketch of the history of astronomy. This science was cultivated in very early times. The question, however, as to what nations first cultivated this science, cannot be definitely answered. But it seems probable that the Chaldeans were the first who, within the range of history, made systematic observations of the stars. The path of the sun among the fixed stars was very early

discovered, and these stars were arranged into the twelve constellations known as the Signs of the Zodiac, long before the historical era. Many of the other constellations were also named, but some were afterwards altered by the Greeks and Romans; and even in modern times a few additions have been made, as, for instance, the Shield of Sobieski and the Heart of Charles I. The zodiacal signs are sometimes supposed to have been connected with the rural occupations of the ancients. Thus, the cluster of stars through which the sun seemed to pass in spring was called Aries, or the Ram. Leo, the lion, had been considered symbolical of the rays of the summer sun. Libra, the balance, tells of the period of equal day and night. Scorpio, the Scorpion, of unhealthiness, of autumn; while Aquarius, the waterman, and Pisces, the fishes, betoken the rains and floods of winter. The names, with their significations given to these zodiacal constellations in the order of the signs, are as follows: Aries, the ram; Taurus, the bull; Gemini, the twins; Cancer, the crab; Leo, the lion; Virgo, the virgin; Libra, the balance; Scorpio, the scorpion; Sagittarius, the bowman; Capricornus, the goat's-horn; Aquarius, the waterman; Pisces, the fishes. It must not be supposed that any resemblance can be traced between the shape marked out by the stars and the figures they are supposed to represent. The original idea seems to have been to map out the sky into convenient portions for examination, and at the same time to immortalize certain real or mythical heroes; but as the system became adopted universally, it has been retained to the present day, and serves as a ready means for distinguishing and registering the stars. Among the most noticeable of celestial phenomena are solar and lunar eclipses, and these, of course, attracted the attention of early astronomers, and at length the true cause of them was discovered. A careful record appears to have been kept of them, so that the *Saros*, or Chaldæan period was discovered. This is a period of 18 years and 11 days, or 223 lunar months, at the expiration of which the moon enters again upon its former track in the heavens, and thus the same eclipses are, as it were, repeated.

The Egyptians seem to have made some progress in astronomy at as early a period as the Chaldæans. Their pyramids indicate their skill in practical astronomy, as they are all so situated that their several sides point very exactly to the four cardinal points, east, west, north, and south. The system adopted by the Egyptians was the following: They conceived that the planets Mercury and Venus revolved like satellites round the sun, their orbits being carried along with him in his revolution round the earth. They supposed the earth immovable, as the centre of the system, and the other cele-

tial bodies to turn round the same centre; first the moon; then the sun, about which they supposed Mercury and Venus to revolve; next the planet Mars; then Jupiter; next Saturn; and lastly the sphere of the fixed stars.

The Chinese date their astronomical knowledge from Fohi, who they say was the first of their kings; and supposed by some of the Moderns, erroneously enough, to be Noah, who, tradition says, journeyed with his children in the direction of China, about the time of the building of Babel's tower.

The wonder and anxiety with which eclipses were witnessed by the Ancients, may be easily imagined, and when an astronomer ventured to predict an eclipse, and his prediction was verified he must have been looked upon as little short of divine. The first instance we have on record in which this was actually done, was in the year 610 B. C., when Thales, a Milesian, the father of astronomical science among the Greeks, foretold an eclipse of the sun. It is probable, however, that the same thing had been done repeatedly before by the Chaldæans and others. With Thales the true history of astronomy begins. But the Greeks were not distinguished for any great proficiency in the natural sciences. We find here and there shrewd guesses and faint gleams of truth; but it is generally mixed up with fanciful speculations, instead of being supported by careful observation and reasoning. They seem, for the most part, to have started with certain principles which had no existence but in their imagination; as, for example, that the earth must be in the centre of the universe, and that, since the circle was the perfection of shape, all the motions of the heavenly bodies must be in circles. Observing the phenomena of the sky, and the apparent motions of the sun and stars, they formed cumbrous and complicated theoretical systems, endeavoring to reconcile these appearances with their theories. Hence we find all the involved mysteries of transparent wheels, revolving one within the other, and carrying with them the planets and stars, of cycles and epicycles, and of crystal spheres in ceaseless rotation, which Plotemy and his followers were ever planning, and ever altering.

We must, however, glance at a few of the names which stand prominently forward in the history of the science. Anaxagoras and Pythagoras were two of the Greek philosophers who succeeded Thales, and they appear to have had much more accurate views than most of their day. They taught *that* the sun is in the centre of the universe; *that* the earth is globular and moves round the sun; *that* Venus is the morning as well as the evening star; *that* the moon reflects the sun's rays and is inhabited; *that* the stars are worlds,

and *that* comets are wandering stars. These celebrated philosophers flourished about 500 B. C., and their system is nearly the same that was adopted or restored by Copernicus in the 15th century A. D., or about 2,000 years after them. Their doctrines do not appear to have been at all generally received in their time, and were condemned by those in power as being impious. Anaxagoras was sentenced to death on account of his philosophical views; but his sentence was afterwards, through the influence of a friend, commuted to banishment for life.

Hipparchus, born at Nice in Bythia, in the second century B. C., appears to have made considerable advances in the cultivation of every branch of astronomy. He gave up all attempts at framing a system for the universe, and occupied himself in carefully watching and recording the motions of the sun and planets. The movements of the sun especially occupied his persevering attention, and in this way he made a very close approximation to the true length of the year; and the accuracy of his observations is very remarkable when we consider the imperfectness of the instruments he had to use. He also observed the irregularities of the rate of the sun's motion, and determined in what part of its course its speed was greatest, and thus ascertained that if the motion of the sun was uniform the earth was not situated in the centre of its orbit.

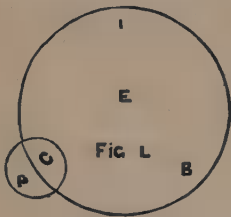
Another thing for which the name of Hipparchus is memorable, is a catalogue of fixed stars which he formed in order that future astronomers might be able to detect any alteration in their position or number. He appears to have been led to undertake this task by the appearance of a new star, and though the work of carefully ascertaining and noting each star was a work requiring great labor and patience, he persevered and completed a list which contained 1081 stars. In the progress of this work he made one very important discovery. On comparing the place assigned by him to a star in the constellation Virgo with that determined by some distinguished astronomers nearly two hundred years previously, he found a difference of two degrees in its longitude. He then made similar comparisons, where it was possible, with respect to other stars, and found the same change in their position. It was then evident that all the stars must have moved forward, or else that the points from which the measurements were taken must have moved backwards. This phenomenon is known as the precession of the equinoxes; the reason of it was discovered by Sir Isaac Newton.

Another idea for which we are indebted to Hipparchus was that of representing the stars on an artificial globe; and of marking the

positions of places on the terrestrial globe by means of lines of latitude and longitude.

Nicias, one of the followers of Hipparchus, is said to have advanced further than his preceptor, and started an hypothesis that the apparent changes in the sky were caused by a daily revolution of the earth. The idea was, however, not supported by any arguments, and was lost sight of for ages.

The only other ancient astronomer we shall refer to in this sketch is Ptolemy, who was born in Pelusium, in Egypt, in the year 69, B.C. He was a very learned scholar for his time, not only in astronomy, but in mathematics and geography. Having carefully examined the observations of Hipparchus and others, he at length promulgated a system known as the Ptolemaic, which, though since proved to be quite erroneous, accounted so well for all known celestial phenomena, that its errors could not, with the instruments then in use, be detected; and accordingly it was universally received till the age of Copernicus, and even then it was long before it was entirely discarded. According to this system the earth is immovable in the centre of the universe, and the planets move round it, in the following order: first, the Moon, then Mercury and Venus, the Sun, Mars, Jupiter, Saturn, and beyond all these the firmament of the fixed stars; all of which were represented as moving round the earth every



twenty-four hours. To account for the apparent irregularities in their motions he introduced what he termed epicycles, which will be understood by reference to the figure where E represents the earth, and A B C the orbit in which the planet should move; but instead of this he supposed that there was a *point* C moving in

this orbit, and that the planet P moved round this point in a small circular orbit or epicycle. The combination of these two motions explained the irregularities. This system was afterwards rendered much more complicated by the alterations introduced by the successors of Ptolemy; and, notwithstanding its absurdity and its contrariety to the appearances of the universe, it continued in vogue, even among the learned, for the space of more than fourteen centuries, or, until the beginning of the sixteenth century. During this period a few individuals appeared who cultivated astronomy, as Almansor, Almanon, and others among the Arabians; Ulugh Beigh, a prince of Tartary; Alhazen, an Arab, in Spain; Alphonso X., King of Castile; Roger Bacon, and several others. These all adopted the Ptolemaic system.

About the year 1472 was born Nicholas Copernicus, who, leaving

all the speculations of former observers, studied for himself the motions of the celestial bodies. He first examined all the ancient observations, and then commenced for himself to closely and systematically examine the heavens. He compared the actual places occupied by the sun and planets with those which, according to former theories, they ought to occupy, and thus obtained a better knowledge of the irregularities and variations than any astronomers before his time. He continued this course for many years, and at length arrived at the conclusion that Mercury and Venus revolved around the sun instead of round the earth. He gradually extended his reasonings further, and at length started his celebrated theory, which regarded the sun as the centre of the system, with the earth and all the other planets all revolving in regular order around it. By this grand idea all the complicated and bewildering schemes which had occupied and puzzled so many observers were at one stroke swept away. Instead of the cumbrous machinery of crystal spheres revolving one within the other, the utmost simplicity is seen to characterize his system; order and regularity take the place of almost inextricable confusion; and as the observer transfers his station of observation from the earth to the sun, the planets which had previously appeared to wander on in ever-varying directions among the stars, now retracing their steps, and then, after an interval of rest, starting again, are seen to be steadily moving on in elliptic orbits around the central luminary of the system. The movements of the inferior planets, Mercury and Venus; the reason why they were never seen very far removed from the sun; the retrograde motions of the planets, and their irregular movements were all clearly explained by this grand yet simple theory.

We can with difficulty recognize the prejudice with which such a scheme was received; the earth was by it degraded from its central place, and reduced to the rank of a planet; and that which men had been accustomed to regard as fixed and immovable was now declared to be in rapid motion around the sun, and at the same time to be ever whirling round its own axis. He seems to have himself foreseen the effects of this prejudice, and hence he waited long before he fully accepted the theory, and still longer before he ventured to make it public. This system Copernicus understood to have been that of Pythagoras, broached 500 years before the Christian era, and hence he wrote a treatise in confirmation of it, entitled "Astronomy restored, or the Revolution of the Heavenly Bodies." This system was at first violently opposed both by the vulgar, the dignitaries of the Romish Church, and pretended philosophers, as contrary both to sense, reason, and Scripture, and many of its abettors were subjected

to violent persecutions. Copernicus himself seems to have had a great degree of deference to the Church and consideration for the prejudices by which he was encompassed ; and the dedication of his work almost takes the form of an apology for venturing to suggest such views, and his ideas were put forward rather in the shape of an hypothesis than of a definite system. It must not be supposed that Copernicus formed a complete system to account for all the motions of the planets ; his life was too short for the task. His work was to indicate the true theory of the universe, leaving it for others to trace out more accurately the exact curves in which the planets moved, and to ascertain their various distances, magnitudes, and rates of motion. It was afterwards ably supported by the writings of Kepler, Galileo, Gassendi, Hevelius, Huygens, Cassini, and other distinguished astronomers, by whom its principles were demonstrated, and established on a firm and stable basis.

This system was especially demonstrated by Kepler, whom we have had occasion to mention before, and who has sometimes been called the " legislator of the heavens," as it was he who first discovered the laws by which the movements of the heavenly bodies are governed.

Almost contemporary with Kepler there lived another great philosopher and astronomer, named Galileo, chiefly memorable now as being the first to construct the astronomical telescope, though his powers were such as would have ensured his renown, even had this great discovery not been made by him. He was born in 1564, and became a teacher of philosophy at Pisa. Here he soon rendered himself remarkable by his strenuous opposition to some of the teachings of Aristotle, which he proved by experiment to be incorrect. This brought upon him much odium, and even persecution ; but though he thus opposed the received views on mechanical subjects, he continued for some time a stickler for the Ptolemaic system, and even refused to hear any explanations of the views and theories of Copernicus. After a while, however, he saw the folly of this, and commenced a careful enquiry, the result of which was that he became an ardent supporter of the new system.

In the early part of the 17th century, Galileo heard of a discovery which had been made by an instrument maker in Holland, by which distant objects could be made distinctly visible. He therefore made every enquiry, and at last succeeded in making a telescope which possessed a magnifying power of 30. This he first directed towards the moon, and here he at once detected many points of resemblance to the earth ; he perceived rugged mountainous parts, and lofty elevations ; level plains likewise, which were at first called

seas. He made a greater discovery, however, when on the 7th of January, 1610, he directed his magic tube toward the planet Jupiter. Not only did it present to him a brilliant disc, streaked across with dark bands, but close to it he perceived three small stars almost in a straight line. These he at first supposed to be merely fixed stars; on the following evening, however, when he again directed the telescope to the planet, he observed that they had moved along with it, and had also changed their positions with relation to each other. Here, then, was evidently some new discovery; and Galileo waited most anxiously the recurrence of a clear evening to enable him to decide the matter. The next view satisfied him that they were in reality moons accompanying the planet; and further, he found that there were four of them.

Intense excitement was created among astronomers by this discovery, some urging the absurdity of increasing the number of the heavenly bodies beyond the sacred number seven, and others angry at the man who attempted to depose the earth from its position of dignity by asserting that Jupiter had four satellites, while the earth had only one. It is said that some even refused to look through the instrument which made such unheard-of revelations. But the followers of Copernicus welcomed the discovery as presenting a miniature model of the solar system, and thus upholding their theory. The telescope soon made other discoveries. By its aid Galileo found that Venus presented the same phases as the moon, appearing at times as a narrow crescent, and then gradually becoming more and more illuminated, till at last it shone with an almost circular disc. It could not, however, be seen with a complete disc, as at such a time the earth must be in the part of its orbit exactly opposite to Venus, which would, therefore, appear in conjunction with the sun, and be lost in his brightness. This was a very important discovery, as it afforded a strong confirmation of the truth of the Copernican system. In fact, an objection had been raised against this system on the ground that these phases were not seen as they should be if the theory were true. The telescope, however, soon settled this difficulty, and silenced these objections. He made another discovery when he examined the planet Saturn. Instead of appearing with a circular disc, like the other heavenly bodies, he found it to be elongated, as if handles were affixed to each side of it. Owing to the imperfections of his telescope, Galileo failed to discover that this appearance was caused by a large ring, which completely encircled it, and he imagined that the planet was in reality composed of three smaller ones. Both these discoveries were, according to the practice of scientific men in those days, made known in anagrams,

only intelligible to those who possessed the key. It is thus seen what an important instrument the telescope proved to be, for not only these, but almost all celestial discoveries since have been made by its use; and now nearly all our astronomical instruments consist either wholly or in a part of a telescope. It is thus seen also to what important results the accident of a child playing with two spectacle glasses has led; for such an accident, it is said, first originated the idea of the telescope.

The career of Galileo, though for the most part a splendid one, was somewhat marred near its close. The prominent position he had taken as an upholder and promulgator of the new doctrines had attracted the attention of the papal authorities, who regarded his views as heretical, and demanded of him a public recantation of his belief in the motion of the earth. This he reluctantly gave, though he is related to have said immediately afterwards: "It moves for all that." This was in several ways a sad scene! Not long after this, in 1642, he died. In the same year was born the illustrious Sir Isaac Newton, a man more celebrated than either Galileo or Kepler, and whom we have taken occasion to speak of before. From this time onward we come across the names of so many prominent astronomers that we can but refer to a few of the more celebrated. About the year 1658 Huygens, a celebrated mathematician and astronomer in Holland, using telescopes of a much larger size than those of Galileo, discovered that the phenomena connected with Saturn was in reality an immense ring surrounding that planet, and, as he thought, thirty thousand miles distant from every part of it. He at the same time discovered the fourth satellite of Saturn; and in these and other observations he used telescopes of his own construction of 12, 23, and even 100 feet in length. Napier had, some 40 years before this, invented logarithms; and thus reduced the work of weeks to days or even to hours; and a little later reflecting telescopes were introduced by Gregory. Some time afterward Cassini, a French astronomer, discovered the first, second, third, and fifth satellites of Saturn, and the periods of the rotation of Mars and Venus.

Flamsteed was another celebrated astronomer, almost contemporary with Newton, and was the first that was called Astronomer Royal. The origin of the observatory of Greenwich, and of this post, was in the year 1695. Great inconvenience had been experienced in long voyages from the want of some method of determining the longitude in which a vessel was at any time, but at length a plan was proposed which was substantially the same as one that is in use at the present time. This consisted in noticing very accurately the position of the moon with respect to neighboring fixed stars. As the earth moves

on in its path this position seems to vary. If then we have an accurate list of these "lunar distances" as they are termed, calculated for any given meridian of longitude, we shall be able to tell by observation what the time is at that meridian. We can then compare this with the local time of the place where we are, and in this way ascertain the longitude; for since 15° of longitude make a difference of one hour in the time, we have only to allow 15° for every hour of difference in the times, and we shall at once tell the longitude. The method of solving this problem usually employed now is merely to compare a good chronometer, set to the time of the observatory, with the local time; but it was not till a comparatively recent period that chronometers were made accurate enough for this purpose, and even now it is a great advantage to be able to check them occasionally by means of lunar observations.

When this plan of ascertaining longitudes was proposed an objection was made to it on the ground that the tables of the positions of the moon and fixed stars which then existed were not sufficiently accurate to be of any practical use for this purpose. It was therefore decided that an observatory should be built and sustained with this especial end in view, and Flamsteed was appointed astronomer to the observatory. This observatory was erected, and the post established in 1675, and from that time to the present some of the ablest astronomers have resided in it, and an *almost uninterrupted series of observations has been maintained*. These have constantly proved in many different ways to be of the greatest practical utility. One main duty connected with this Observatory is the preparation of the "Nautical Almanac." This is an almanac published three or four years in advance, and containing a large number of important astronomical tables. The position of the moon with respect to any of the fixed stars is shown for every third hour throughout the year. The position of the various planets is also exhibited, as well as the eclipses and occultations of Jupiter's satellites, and many similar tables which are useful to the navigator in ascertaining his position, as well as to the astronomer. The reason of its early publication is in order that captains about to set sail on long voyages may have it to take with them.

Though this observatory was thus founded by the British Government it was some time before it was provided with instruments worthy of the place: Flamsteed having to use his own for a considerable period. This astronomer was a very painstaking observer; and it appears to have been to his accurate observations that Newton was greatly indebted in many of his investigations.

Halley succeeded Flamsteed in his position at the Observatory.

He was for some time an intimate friend of Newton, and made several long journeys in the interests of science. An expedition was fitted out under his charge to observe and catalogue those stars in the southern hemisphere which are invisible with us; and a list of nearly 400 was compiled. This, however, was by no means a complete one, as the station chosen for observation, St. Helena, was in many respects unfavorable. After Newton had made the discovery that bodies under the joint influence of a centrifugal force and the attraction of a central body might revolve in a hyperbola or parabola, as well as in an ellipse, the appearance of a comet was anxiously awaited in order that, if possible, it might be ascertained whether these bodies moved in fixed orbits of either of these forms, or whether they were merely stray wanderers dashing swiftly past our system, and then forever lost in the deep abyss of space. In the year 1680, this desire was gratified by the appearance of a very remarkable comet, which attracted great attention, both by its brilliancy and the rapidity with which it travelled. Halley gave his earnest attention to the observation of this body; he accurately noticed and recorded its motion, and he discovered that a parabolic orbit could be constructed which would account for all its movements. Its eccentricity was, however, so great that a period of 600 years must elapse before it could again return to the sun.

After this comet had passed away Halley still devoted his attention to the subject, carefully enquiring into the recorded appearance of different comets, with a view to ascertain whether the intervals between the appearances of any of the most noticeable ones appeared in any way uniform. Shortly after this, in the year 1682, another large comet appeared, and Halley now with the information he already acquired was in a better position to enquire into its motion. He accordingly did this, and after a time announced that he had calculated its orbit, and found that it moved in an ellipse, its aphelion distance being nearly 3,500,000,000 miles; also that its period was about seventy-five years. He then looked back through his list of comets, and found that he could distinctly trace it back for a considerable period. This so far confirmed his calculations that he distinctly foretold its reappearance about the close of the year 1758; and so convinced was he of the truth of this prediction that he requested, since he could not live to witness its return, that when it was fulfilled people might remember it was an Englishman who had first traced the path and prophesied the return of a comet.

Long before the date assigned for the return of this comet, which began now to be known as Halley's, he himself had passed away. Astronomers were, however, on the watch, and some French astrono-

mers, in particular, investigated most carefully and industriously the retarding effect which would be produced on the comet by the attraction of the planets, and as a result of their enquiries announced that it would be slightly delayed by the action of Saturn and Jupiter, so that its perihelion passage might be expected on the 13th of April, 1759. Just at the close of the previous year, a wanderer was detected by an amateur, and as it approached nearer, it proved to be the very one, whose return had been for so long a time foretold; and though its period of revolution was upwards of three quarters of a century, yet the observations and calculations were so accurate, that it actually passed the sun within less than three weeks of the predicted day. On the occasion of the next return of this comet, which took place in 1835, not only was the date, but the place of its appearance pointed out, and on a large telescope being turned to that spot, the comet was seen as a faint cloudy object. We see thus that Halley's comet was now to be reckoned as one of the members of our system, whose motions are fully understood. Its next return may be expected in the year 1912.

Bradley succeeded Halley as professor of astronomy at Greenwich. The great discovery which has rendered his name memorable, is that of the *aberration* of the fixed stars. The aberration of the stars is a small change of place in the heavens, which, in consequence of the earth's revolution in its orbit round the sun, they appear to describe in the course of a year, an ellipse or circle, the greatest diameter of which is about 40". These apparent changes of place, occasioned by the annual motion of the earth, are to a certain extent common to all the celestial orbs, and are only the more perceptible and striking in the case of the fixed stars. In consequence of this annual revolution of the earth round the sun, the stars appear, according as they are situated in the plane of the ecliptic or in its poles, or somewhere between them, in the first case to deviate in a straight line to the right or left of their true place; in the second, to describe a circle or something nearly approaching to it around their true place; and in the third, an ellipse about that point which observation determines to be their real situation. The angle contained between the axis of the telescope and a line drawn to the true place of the star, which angle, in consequence of the earth's motion, must be continually changing, is what is called its angle of aberration. The aberration of the stars appears to afford a sensible and direct proof of the motion of the earth in its orbit round the sun. If the earth were not in motion, no such effect could take place. If the earth were at rest, the star would be seen in the place in which it really is, never seeming to alter its position; but the earth being

in motion with its present velocity, the telescope is necessarily inclined a little in order to see the star, and it is the real annual orbital motion of the earth that causes the apparent motion of the star, in describing such a figure in the course of our year.

Dr. Bradley also took an active part in the reform of the calendar, which had by this time varied a little from the true seasons; and, in order to rectify the error, joined in recommending that eleven days should be struck out of the month of September, 1752, so that the day that would be the fourth of that month, was called the fourteenth. This measure was very unpopular at the time, and Bradley came in for a large share of popular dislike on this account; and his death, which occurred a few days afterwards, was, by many of the ignorant, regarded as a mark of Divine displeasure at his presumption in thus daring to interfere with the regular order of the calendar. This alteration has since been effected in nearly all countries, except Russia, where dates are still reckoned according to the old style, and are now thirteen days behind those used in the rest of Europe.

We may now just glance at the services which have been rendered to astronomy by another of those men whose names will ever stand foremost in its annals, Sir William Herschel. He was a man of somewhat humble origin and unable to procure a telescope sufficiently powerful by which to understand some of the mysteries of the heavens. He had, however, an intense desire to do so, and having acquired a knowledge of the principles of the telescope set himself to construct one. In this, he succeeded well; and he is said to have ground altogether upwards of 500 specula for reflecting telescopes. In March, 1781, when he was examining the sky by the aid of one of these instruments, he came upon a small star, which as he examined it with higher powers seemed to exhibit a disc. He accordingly took an accurate note of its position so as to watch it again on another evening. When he again examined it, it was at once clear that it had changed its position. The idea, however, of a new planet does not appear to all to have entered into his mind, so accustomed had every one been to regard Saturn as the extreme planet of our system; accordingly, he set it down as a new and strange comet which he had discovered, and announced it as such. Its motions, however, soon showed that, unlike the comets, it moved in an orbit of but small eccentricity, and it was then found to be a planet revolving in an orbit outside of Saturn. This planet he named *Georgium Sidus* in honor of King George III, who had been his patron, but the name was afterwards altered to Herschel, and finally to Uranus, by which name it is now known.

Soon afterwards he constructed a much larger telescope, the speculum of which was four feet in diameter, and the tube forty feet long. The space-penetrating power of this instrument was reckoned at 194, that is, it could enable the observer to see into space 194 times as great a distance as could the unaided eye. With this he discovered two more satellites of the planet Saturn; six out of the number that revolve around Uranus were also detected by him; so that he made a very large addition to the number of the heavenly bodies then known. But his most important discoveries were made about the stars and nebulae. A large number of double and triple stars were first observed by him and carefully noted, with a view of determining, if possible, whether any of them exhibited any sensible parallax. The Milky Way was also resolved by the power of his magnificent telescope, and thus some idea was formed of the size and character of the cluster of which our whole system forms but an insignificant fraction.

Sir John Herschel, the son of this distinguished man, who died recently, displayed a similar love for astronomy. In conjunction with Sir J. South he produced a catalogue of 380 double stars, whose distances and angles of position they had determined. Sir J. Herschel afterward produced a list of upwards of 3300 double and triple stars from his own solitary observations, accompanied with all the micrometrical measurements; and he also undertook a journey to the Cape of Good Hope for the purpose of making observations in the southern hemisphere of the heavens, and made many interesting discoveries both of stars and nebulae. Other astronomers we have named in the other places in connection with certain discoveries, and there are still other distinguished ones which we would wish our space permitted us to mention. There is, however, an astronomical instrument which we may refer to before closing this historical sketch of the science, as having been found of great use in determining many difficult points. This is a reflecting telescope constructed by the late Earl Rosse, the speculum of which is six feet in diameter, and its focal length fifty-four feet. Its higher powers, however, owing to the amount of moisture in the atmosphere, can only be used at rare intervals. This instrument, though not so clear in its definitions as telescopes of lesser magnitude, such as the large one of Herschel, may still fairly be considered as one of the wonders of the age.

CONCLUDING REMARKS.

From all the facts which the science we have now reviewed has revealed to us, both in relation to the world in which we dwell, and

to all the other luminous and non-luminous worlds which surround us, in the heavens, on all sides, infinitely, it is evident that astronomy intimately and necessarily pertains to the demonstration of the subject which it is our endeavor to elucidate, the subject of Creator and Cosmos. Confined as man is to this terraqueous globe, and to only a limited portion of it, he could have no worthy idea of the great universe, or of the glorious worlds which surround him, did not the earth itself afford him the means, in the telescope, of enlarging his views with respect to them. This noble instrument, as well as the microscope, by which we become acquainted with the invisible world in the other direction, is made of what are regarded as the humblest of earthly materials; still, but for their use we might be today in the position in which the people of 1500 or 2000 years ago were, having no definite knowledge, and constantly changing our views and groundless theories, as to the system of the universe and Infinite existence.

There is nothing more evident than that man is of the same nature in every respect as the world in which he dwells, the media in which he lives and moves. He is, in fact, as any other creature that exists in it, a part of it. It is quite as evident, from what astronomy and other sciences teach us, that the earth is of the same nature as are all of those glorious worlds by which it is surrounded. It is, in fact, if we may so express it, a part of the universal whole. We see all these orbs, co-existent in space, in mutual dependence on each other, as are the members of the human body; yea, and more so, for the human body may lose one or more of its members; but one of those heavenly bodies, a member of the great universe, cannot be lost, not a particle of it. They all universally obey the same laws proceeding from that simple principle of gravitation, a principle which not only *preserves their existence in the forms in which they are, but also governs their motions and confines them exactly to their own places.* We see that the principles of light and heat and gravitation act exactly alike, and equally, with respect to them all. This effect is abundantly sufficient to teach us that they are all of the same general substance; but of this fact we have sensible evidence by being made, as it were, intimately acquainted with the surfaces of those that are nearest us by means of the telescope, and with the nature and constitution of those that are far distant from us by means of the colors of their light, and *spectrum analysis.* They are all the same general substance, the same spirit pervades the whole; they are all *individual members of the infinite whole.* When we walk abroad and see a laborer digging a ditch or a pit in the earth, the thought sometimes strikes us that the substance on which that laborer is operating is

just the kind of substance of which we ourselves are composed, and to which we shall one day, perhaps ere long, return, as it has happened to an infinity of our predecessors of mankind. And yet how few there are of mankind to whom such a thought ever occurs in its proper sense; men are accustomed to look upon such things as altogether beneath their notice; and not to allow such thoughts for a moment to occupy their mind. They look upon the earth as a dead thing, devoid of life; and yet it is full of the principle of life; there is not the minutest particle of lifeless matter in the whole earth, nor in the universe; yea the earth itself, as well as all worlds, is all existing in life. We who are present are accustomed to think of the earth as a dark, cheerless abode, and to wish that our lot had been to live in some of those bright worlds we see surrounding us; but were we situated on the moon, or even on the planet Venus or Mars, we should behold what a glorious orb our earth appears from thence; it partakes of that glory which we have seen to characterize the other heavenly orbs; being of the same nature, it is no less intrinsically good and glorious than they. Why then should we be discontented with our abode? Why should we wish to transfer our residence from it to other worlds which are not superior to it in kind? Why should we be afraid when we die to have our bodies return to it, in hopes that they may again arise superior in scale of being to what they now are? We should always cherish the strongest faith and hope that we shall live intelligently and happily after death, and should live to be good and to do good. We should use the gifts and privileges which the world affords us, as not abusing them; we should obtain them and use them in the best possible manner; we should in fact live in such a way that we should never be afraid to die; and thus we should in reality find that our world would present to us a heavenly aspect, a delightful abode with which we would be contented, and which we would not be desirous of exchanging for another. We should endeavor to attain, while living here, the first resurrection, that is, the resurrection, or new birth, from the death of sin to the life of righteousness. We should crucify the natural man, with its affections and lusts, denying ourselves the inordinate pleasures of the world and all ungodliness, and living soberly, righteously, and honestly in this sphere of our existence. We invite all to take this course, and we promise them, thus doing, thus living, they will experience a heavenly peace and happiness in themselves such as the followers of natural and worldly pleasures shall not experience; and they shall not be afraid to die when their time comes to die. They will come to know God, and God will always support and comfort them, and be a near and true friend to

them, in whatever condition they may be in life; they will also be taught of God, and great shall be their peace!

Blessed and holy are they that have part in the first resurrection; on such the second-death shall have no power; even the approach of their natural death they shall not fear; it will present no terrors to them; resting in the faithfulness and goodness of the Lord, their minds are stayed in perfect peace; they shall be priests unto God, and shall reign with Christ forever!

It will give us pleasure if our readers have had their knowledge increased, or have had some of their suspicions on some things, which have hitherto been dark and evanescent in their minds, changed into well-grounded and intelligent conclusions by the perusal of this First Part of our work. When they have perused its Second Part, in which we propose to, in some degree, remove the veil of mystery which has hitherto overspread religious subjects, and which in past, ages has induced so much error and superstition among mankind, they will be better prepared to judge of the whole subject of the book, and of the conclusions which have been so far demonstrated concerning the subject of the Cosmos. Our work for mankind is certainly such as may be called a labor of love, and "perfect love casteth out fear" as well as precludes the idea of compulsion; the setting forth right conclusions concerning the subjects under consideration was with us a matter of moral principle; nor was the idea once entertained either in its plan or preparation of pleasing either publisher or reader at the expense of the truth. We only expect, then, that due respect will be given to demonstration, and that whether this is so clear as to amount to conviction, or partly to amount to conviction, the matter under consideration will be discussed freely and in the proper spirit.

NOTE — The Second Part referred to is "Cosmotheologies and Indications of Judgment," which begins vol. II of my works.

FOUR COSMICAL LECTURES OR COSMOTHEOLOGICAL ESSAYS

WHICH WERE DELIVERED IN DIFFERENT PLACES ON DIFFERENT
OCCASIONS BEFORE VARIOUS AUDIENCES: AND ARE HERE
INTENDED TO COMPLETE THE WORK
"CREATOR AND COSMOS."

BY

ROBERT SHAW, M. A.,

▲UTHOR OF "COSMOTHEOLOGIES AND INDICATIONS OF JUDGMENT," ETC., ETC.

- I. IS SCIENCE RECONCILABLE WITH RELIGION.
- II. LIBERTY AND ITS LIMITATION AS TO ACTION, AND INVESTIGATION OF
THE COSMICAL PHENOMENA, ETC.
- III. THE GREAT PYRAMID OF ÆGYPT.
- IV. PROOFS FROM NATURE OF THE EXISTENCE OF GOD AND OF HIS GOV-
ERNMENT OF THE WORLD.

REVISED.

ST. LOUIS:
BECKETT & COMPANY.
1889.

PART SECOND OF C. AND C.

IS SCIENCE RECONCILABLE WITH RELIGION?

A DISCOURSE which epitomizes the fundamental principles of this book, and sets forth concisely the author's understanding and development of those principles:—

In commencing to discuss this subject "Is science reconcilable with Religion?" I may, first, state by way of definition that a Science is a collection of Natural Principles or Laws which, if applied or used by art in certain ways, will invariably produce certain effects. The Science, therefore, is the What, the Art is the How: the Science is the knowledge, the Art is how to apply or use it in order that the results may follow. In the progress of the discussion I may give you some hints as to what religion is not; and then, from what I may say after, leave you to understand for yourselves what religion is. I have, however, under the idea of religion to deal to a good extent with the Science of Theology, as the belief in the existence of an omnipresent and omniscient God is the foundation of all true religion. Secondly, whatever I may be able to do in proving Science reconcilable with religion I wish it understood that I do not attempt to prove all Scientists reconcilable to religion.

In our days much is said about the progress of Science and the discoveries of Science. The class of professional Scientists although in the main they do not speak with disrespect of religion nor live openly immoral lives yet cannot be said to be champions of religion, that is, they in the main do not interfere with it or with the book from which the popular religious views of Europe and America have so long been drawn. From first to last of them they appear to have been loath to undertake the Bible as if they understood themselves not to have been born or fitted for its interpretation, and if we except Newton who not only wrote the *Principia* but interpreted the prophecies of Revelation we find but few of those professionals who undertook the Scriptures. They may, 'tis true, have understood that the pursuit of one branch of learning is quite enough for one class of men, leaving theology to be understood and taught by another class whom making this latter branch their specialty they considered more competent for that work.

It cannot be denied that in the period since the discovery of America by Columbus, Science has made its greatest advances; also the useful arts or those which tend to abridge manual or animal labor, and if discovery and application advance at an equal pace for one hundred years to come with that at which they have advanced

for the last century we can now hardly begin to estimate the effects upon the population of the earth at the end of that time. Nor can it be denied that the opening up of America to the masses of Europe has tended to greater freedom of religious thought, to greater development of religious views, and to the origination of religious sects and systems in which these views are embodied and enunciated. This diversity of opinions doubtless existed in the old world but latent, for the people of Europe were for long ages restrained by law from developing them publicly, however ardently they might have cherished them, if they contradicted even in sentiment the established systems of religion. This freedom of religious thought tends to freedom and earnestness of inquiry, which, if carried out in the proper spirit as well in the field of science as of theology, tends to correctness of understanding and to development of mind and thence to the energizing and invigorating of the masses. This then must be productive of beneficial effects for the body is subject to and obeys the mind, and the mass of individuals with well-regulated, intelligent, and active minds may be expected to be a better-ordered and more effectual, in short, a more energetic and useful mass for themselves, for the church, and for the state, than the mass of individuals of inactive minds that are led and governed by one controlling mind. I do not here intend to say that this correctness of thought and this development of mind are attainable at once on the act of emancipation from the slavery of system to religious freedom, but, I do say, that like the complete education of a youth they are attainable gradually; and this state of education or gradual educational progression which I have indicated is, I believe, the state in which Protestantism with its innumerable religious opinions and the free tending elements of Catholicism are to-day. This gradually progressive state is pertinently indicated in that prophecy of the book of Revelation, referring to the age we are now passing through, which represents the angel with one foot in the water and the other on the land, in the act, as it were, of passing over to the firm and dry land of settled opinions and definite understanding in religion.

It appears to me plain that the denial of religious freedom by governments is not only unjust in itself, but somewhat inconsistent with the fact of the omnipresence of Deity, which shows the absurdity of one man or one corporation of men arrogating to himself or to itself all knowledge concerning him or his will. The most, then, that governments should do or should be expected to do in such case is to give their moral support to that system of religion which unites in itself simplicity with truth and earnestness, and appears, all things considered, to be the best. But this, you will perceive,

leaves complete religious freedom to the masses. As that is not religion by whatever name called which fosters a malignant or persecuting spirit, neither can that be called religion which tends to libertinism and immorality, to laziness and the neglect of active duties which are too often the concomitants of socialism, or to the derangement of moral order or the suppression of the instinct of true Christian love and affection in any way. The object of secular government is partly to preserve order among the masses of the people; its right should, therefore, be recognized to preserve order in a religious corporation or assembly, when the latter transgresses the laws of the state, which in most cases are quite minute with respect to the moral obligations of the individual.

The religious freedom of the age in which we live allows to scientists the privilege of pursuing their investigations, of developing their theories, and of expressing their opinions as freely as they please; and the results to which they come are taken up and used by religion *pro* or *con* as these results may be thought to favor or disfavor itself. Hence, science has of late years made great advances, the theories propounded have been freely and widely discussed, and they are reckoned low, indeed, in the scale of intelligence who are not able to speak generally concerning the Sciences, their advances, and discoveries.

But referring to my main subject, "Is Science reconcilable with Religion?" I may here state without fear of being proved false in the assertion that there is nothing in the Bible which if properly interpreted shows them to be irreconcilable. The mistake which Scientists who have read the Bible as well as imperfect theologians have made was in too often giving a wrong interpretation to the Scriptures, applying a literal interpretation to figurative language, and sometimes conversely, and thus necessitating that the records contradict themselves. But if the Bible when properly interpreted, will not throughout contradict itself nor contradict Science, this interpretation will, perhaps, be in the main somewhat different from what it received in the times of the Kings Henry, James, and Charles, and even in the time when many of you were young, when theologians especially of certain schools were so unyielding in support of their assertions, in many cases, of what might be called their "hard sayings," and so terribly impatient of contradiction. There is too much of this inflexibility characteristic of the old schools of theology to-day, and in our own free country we may now and then meet with an inflexible specimen of the profession theological. Yet the difference now between the European and the American schools of theology appears to me considerable, the latter not being held so rigidly by

creed or formula or thought of Sacerdotal Caste as the former, but displaying, in the main, as the mass of the American people, the free democratic American manners, and uniting in their pulpit discourses a pertinence, practicality, earnestness, and energy productive of excellent effects. They appear, too, to have begun clearly to recognize that their mission is to be life-imparters, and that to this end in certain cases, as to effect a reformation from a state of moral degradation and self-imposed wretchedness in individuals and communities they are to bring not peace on earth but a sword. Neither is education and intelligence at such a low ebb amongst us as to allow that the minister should be blamed for the performance of his duties; nor does our broad and promising country with all its avenues of labor, of service, and of advancement, where every one may rightfully feel full of hope and honorable aspiration, where all belong to the same Caste; neither does this broad country, I say, necessitate that the minister should refrain from associating with the people, who may often have something to communicate to him even on theology which it will be well for him to know, through fear of his losing Caste or position or the people's confidence or respect by such association.

The time was in our fatherland when society was so bound up by the thought of Caste and order as to divide the people of the same country into many societies, each jealous of its own assumed rights and privileges, and each, perhaps, looking with contempt upon those below it in the scale or with envy upon those still higher up. This state of things still subsists in the old world, but methinks the bands of society are much less tightly drawn, and the thought of Caste much less predominant than they have been in the past, and this liberalizing change has been effected there principally, I believe, through the agency of America and its free institutions.

If the discovery of America is due to the Church through the agency of miracles or otherwise I have not yet learned the fact. Why, it has been asked, did not the church by its miraculous powers cause America to have been discovered before, and thus have presented its broad lands to the millions of the old world starving and downtrodden for long ages?

The church, 'tis true, was quite militant upon land until it carried its banners to the shores of the Baltic, the Caspian and the Euphrates, but it did not cast its omniscient eye over the broad Atlantic, it appears, nor descry in the distance the millions yet to be subjected to its peaceful sway. The church had no navy for exploring expeditions, it was no mariner, but depended rather upon the secular power for the discovery and conquest of new lands, and when this

was done, it, like a faithful housewife, set itself to organizing and housekeeping.

Thank God that we are now favored with this broad, and free, and enlightened country to which since its discovery the outcast of Europe, who had dared to think for himself and speak as he thought, has often hitherto directed his steps in order to find a place in which to live in freedom and peace. I say all this, however, without intending any unfriendliness toward the land of my fathers, the British Nation, which, if we except its aristocratic institution whose interests appear contrary to those of the masses of the people, is, aside from America, the freest country in the world, and to whose sons and their descendants the progress of America hitherto is in a very large degree attributable. Nor have I the least idea that the inhabitants of the British empire now, or the inhabitants of any other nation, are responsible for any evil deeds that may have been done by their ancestors or are on any such account to be objects of my hatred or envy. But it is well known that the free institutions of America have reacted upon the established institutions of Europe and necessitated a liberalizing modification of their regime to which the institution of the Sacerdotal order there is not an exception, and which has wrought good for all concerned as even a large body of the clergy there will allow.

Although religion and Science may go hand in hand and mutually assist each other if they so will, still theology considered as a Science exists independent of Science commonly so called, and this latter exists independent of theology, nor are they found to contradict each other if the proper understanding be had on both sides.

While Geology, although not a Science properly so called, proves unmistakably that this planet has existed for countless ages much as to phenomena as we now see it to exist, it does not disprove the Scriptural passage if rightly interpreted that, "In the beginning God created the Heavens and the Earth." The key to the interpretation of this passage is doubtless to be found in the following passages: "In the beginning was the word and the word was with God and the word was God." "All things were made by him and without him was not anything made that was made." "The word became flesh and dwelt among us and we beheld his glory, &c.;" that is to say, this word was the spirit of Christ or of the God Man, in whom of all the creatures is pre-eminently represented and developed the *Logos* or the reason with speech. By Man I mean man as to form, appearance, &c., as we now see him to exist and in all these respects man is a creature. But, contrary to the hypothesis of Mr. Darwin in this particular, I have no cause to assume that the reason or head domina-

tion which now characterizes man was at any period joined to and supported by any other form than such as we see man now to possess. Therefore, this substantial form of the word must "in the beginning" and before the creation referred to have had a substratum or that by which to be supported while creating all things that were created. We do, however, believe the world now exists; we see it to exist, and if we think this to be the substratum for man now, may we not think it to have been his substratum before and while creating all things that were created? All our laws are made, all our moral obligations entered into, and all our courthouses and penitentiaries built in accordance with our actual experience of the reality of the world; it therefore behooves men to live according to reason and law for their present welfare and for their present and future welfare to worship God who is a Spirit in spirit and in truth. But still I may be allowed to think that our ancient Saxon fathers were wiser than many of our modern sages when they applied to the mental principle or rather to the reason the term *understanding*. The demonstrations of the Science of Astronomy now made are based upon the associated laws of gravitation and of motion enunciated by Sir Isaac Newton and Kepler, the former born in A. D. 1642, and the latter just preceding him in time, and upon the law of *Inertia* demonstrated in the Science of Mechanics. The law of gravitation is stated as follows: "*Every particle of matter in the universe attracts every other particle with a force proportioned to the amount of matter in each and decreasing inversely as the squares of their distances.*" The law of *Inertia* is, that "*bodies at rest will remain at rest and bodies in motion will continue moving in straight lines if not acted on by controlling forces external to themselves.*" The reason the heavenly bodies do not move in straight lines is because of their attraction for each other deflecting them mutually into curved lines, such as circles, ellipses, parabolas, and hyperbolas in which the moons, planets, and comets move. As to the laws of motion deduced by Kepler, I think it unnecessary to state them here but they can be found in almost any treatise on Astronomy, as that in the present work.

These associated laws, however, were mathematically demonstrated by Sir Isaac Newton in his *Principia*, a work which is the basis of our present system or science of Astronomy, and any imperfections which might have been left in the demonstrations by Newton at his death were carefully attended to and the system perfected by his astronomical coadjutors and successors, especially by Flamstead, Halley, and Bradley, who were the first three astronomical professors at the observatory at Greenwich.

It should be borne in mind that the Science of Astronomy does

not propose to account for the origin of the spheres or of their motions, but taking these as it finds them, and following out its own principles and laws, it accounts admirably well for the celestial phenomena.

If some of the points embraced in this Science, such for example as the parallelism of the earth's axis during its journey round the sun, the revolution of the earth upon nothing, the earth's motion round its axis being in a contrary direction to that in which it moves round the sun, and its motion toward the constellation Hercules being in a still different direction, that the moon makes one revolution on its axis while making one revolution round the earth while it is always seen to present the same hemisphere to the earth;—if some of these points, I say, do not satisfy the reason of some moderns, who have never thoroughly mastered the Science, this is no proof against its correctness; for that Sir Isaac Newton and his associates in founding the system had all the principles, bearings, and relations of the Science plainly comprehended in their mind, there can be no reasonable doubt. If not, it may be asked, whence comes the unvarying correctness of the results. But that they had even the capabilities of the Science for application to future discoveries in the solar system plainly comprehended in their mind appears evident in many after results, notably in the discovery of the planet Neptune, which may be called the greatest triumph of the Science, an almost infallible proof of its correctness. The laws of the Science embrace and govern not only all the planets, satellites, and comets known in the solar system in the time of its founders but all that might afterwards be discovered in it. They also embrace and govern all the celestial bodies in all space, being universal in their application and operation. It appears to me that before we allow *that* Science which accounts so well for the celestial phenomena to be set aside or even disputed, we should require another or others of the genius and ability of Newton to disprove it.

The Ptolemaic system of Astronomy invented by Ptolemy, an Egyptian Greek, who was born in the year 69 B. C. was that according to which the celestial phenomena were calculated before the age of Kepler and Newton. This system regarded the earth as at rest in the centre of the universe with all the other heavenly bodies, sun, moon and stars, revolving around it once a day. It was thought to account well for the celestial phenomena, and it was not till the time of Copernicus and Galileo, or say one century before the birth of Newton, that it began to be shown to be erroneous. It is not impossible that the Newtonian system may in time be replaced by another, probably by a modification * of itself.

* Long observation of the effects of the precession of the equinoxes, alluded to on page 301, may possibly render this convenient.

As to forms, motions, &c., the universe gives to all the same general impression. If our mind was differently constituted we should, no doubt, perceive it differently. I do not know that the mind of man was ever constituted differently than it is now; if not, men have always had the same general impression of the external world. The conclusion, then, to which we have come thus far is that man's general impression or idea of the universe is from age to age the same or differing almost imperceptibly,* and his theories to account for the celestial phenomena do, from mental causes, change in time.

To see, or to perceive, or to conceive, as well as to make, is, in a sense, to create. We know nothing whatever as to the origin of the forms, motions, &c., of the earth and the celestial bodies. Science has nothing to do with such origins, and theory or speculation should never be confounded with nor mistaken for Science. Time spent in the investigation of such origins is, in my opinion, time lost. Our life's experience show us the continual origination of existences, animal, vegetable, and mineral, in obedience to a continually developing creative law, which we always see in operation. This is, also, in a proper sense creation; with this creation and with those of our own powers and perceptive faculties we shall have to be content or take other supposed creations on faith.

Matter is, in general terms, defined to be everything which is recognizable by our senses. It is supposed to be made up of infinitely small particles called atoms, which are accounted so infinitely minute as to be altogether beyond the recognition of our senses. These are supposed, also, to be indestructible by any other power than that which has brought them into being. All things are composed of these ultimate elements and all things are consequently reducible into these elements. Hence, and from other considerations, it is known that all the globes and all the objects in space are reducible to the state of an invisible gas, a gas doubtless many times rarer than the air we breathe; that is, they are of a nature reducible, but so far as we know are not practically reducible. This, therefore, is literal spirit, for spirit from the Latin word *Spirare*, to breathe, is that which we breathe, or breath. Hence, all matter is spirit, and, conversely, all spirit is matter. The ultimate elements of matter we cannot possibly recognize, and yet all things we do recognize are made up of these irre recognizable elements. This is the reason why matter is said to be infinitely divisible. You see, therefore, matter and spirit are the same substance in different states, and we cannot conceive anything but what is or is of matter. There are what are called simple substances and compound substances in nature. The simple substances thus far discovered are about 63 in number, and these, with

* See, however, "New Astronomy," by Dr. Trastour: B. Bloomfield & Co., New Orleans.

those that may exist undiscovered, form all the compound substances in our earth and atmosphere. When we say that the ultimate elements of matter are wholly irrecognizable by our senses, we do not mean that such elements do not exist; what we mean is that such elements, though they be real, can be with us only creatures of the imagination. There are some very ingenious theorists who make these atoms (infinitely minute as they are), to be like the soap bubble, and filled with electricity. Consequently, according to them, everything is but a different phase of electricity; but who will undertake to explain that? There are some, also, who claim that spirit cannot possibly be conceived or explained; consequently, according to them, there can be no literal spirit, only imaginary spirit. Now, God is a Spirit, but that he is merely an imaginary spirit I do not understand, for even my faith will not rest on the merely imaginary, but requires for a basis the substantial and real; but, although from his infinite nature he is altogether inconceivable by us, he is yet a real spirit, as his omnipresence attests.

The theory of the atoms or ultimate elements of matter is the basis of the science of chemistry, which is as demonstrable as is that of Astronomy. While contentedly leaving to chemistry its elementary atoms, which are as necessary to it as is the theory of gravitation to Astronomy, I remark, that the originator and substratum of the electricity contained in the atomic soap-bubble, must be the *Ego* or *understanding* which is infinite and inconceivable.

Affinity is a term of Chemistry applied to that force by virtue of which two or more simple substances combine to form a compound body. This compound exhibits properties different from those of the combining components, and is called a chemical compound. Some simple substances display for each other a greater affinity than do others. The laws of chemistry or chemical affinity, and of crystallization, which come within the general law of mutual attraction established by Newton, when that is fully explained, destroy the supposition of anything in the way of progressive creation taking place by chance.

A knowledge of the science of Light and of the Science of colors shows that without light there could be no colors, and that without colors, even if light existed without them, there would be no objects distinguishable, or if they could by their forms be distinguished it must be with great difficulty and perplexity. Light is therefore, in part, the producer of colors, and the difference in colors serves, in part, to produce objects. From experiments carried on at great length of late years, it has been concluded that light as well as heat is a "mode of motion" arising from the violent agitation of the ultimate elements of the luminous body in their seeking equilibrium by

chemical separation or combination : and we know that the phenomenon of light as distant from the luminous body, which is its source, is simply the image of the luminous body infinitely multiplied in all directions and visible distances from it. The light of the sun is accounted for by scientists in two different ways, some supposing that it arises from combustion of the sun's substance, and others that it arises from a magneto-electric state of the sun's atmosphere, so that on this supposition it might be regarded as somewhat of the nature of a continuous surpassingly brilliant northern light with us. Neither of these suppositions it might be shown necessitate the sun's entire consumption in time, for, according to the laws of gravitation, a particle of the sun's substance, even though continually in a state of change, can never go beyond the sphere of his attraction so as to be entirely lost to him ; and as to the second supposition, we can hardly consider an electro-magnetic state of the sun's atmosphere as destructive of his substance.

While white is produced by the union of all colors, black is no color, or only the absence of color caused by the substance which appears black *absorbing* the colored rays which fall upon it. The different colored rays in their order on the spectrum are red, orange, yellow, green, blue, indigo, and violet, that is, red is least and violet most refracted. It was Sir Isaac Newton that made the discovery not only that white light is a compound of rays of various kinds, having different colors and indices of refraction, but that all the substances that appear colored when illuminated with white light derive their colors only from a kind of "Natural Selection," that is, the substances according to their nature may reflect certain colored rays and absorb or transmit others. He concluded, however, from different experiments on the same subject that *every substance in nature, provided it be reduced to the requisite degree of thinness, is transparent.* This is, also, plain from the fact now generally understood, that all substances in nature are, by the application of a sufficient degree of heat, reducible to a transparent, invisible gas. Many transparent mediæ reflect one color and transmit another ; gold-leaf, for example, reflects the yellow, but by holding it up against a strong light it is found to transmit a sort of green color.

By modern scientists who have experimented at great length upon the science of colors and complementary colors, it has been concluded with probability that *what we name colors with their different hues are only the various affection of the optic nerve by a greater or less quantity of light radiating from a focal point in an imperfect reflector.* All this will be better understood by reference to the operations of the science of light and of the science of colors in treatises on those

sciences. From what I have said and will say one can acquire some faint idea of the construction of the mind for perception and judgment. The five senses furnish the reason with all the material or data (the eye performing a very important part), and the reason disposes, judges, and determines. They perceive form, color, motion or rest, weight, hardness or softness, density or rarity, many or few, diversity or sameness, light, shade or darkness, up or down, east or west, &c. The ear perceives language addressed to it in words, or the eye as found in books or in nature; the palate perceives the different tastes, the nose the different smells, and the touch the different degrees of hardness or softness, of intensity of cold or heat and the like; and all these objects are instantly presented to the reason or understanding which disposes and judges of them. Hence the senses are the channels through which we have knowledge of and hold converse with the external world. That light, heat, electricity and gravitation all act according to the same law—their force decreasing as the square of their distance from the centres of action increases—proves them all to proceed from the same source. The source of this action is the understanding, the operation is universal, and the centres of action infinite.

There have been some who have undertaken to demonstrate that there is no external world, that the things we see are only ideal, the real and inconceivable being their substratum. This may seem hard to reconcile with the freedom of the creatures, especially with the free agency of man, which enables him to do or not to do as he may choose. "If," it may be said, "as according to this theory, and in the ordinary sense of the word idea, 'the world be only ideal, there is but the creator and conceiver of ideas or God and man existing, and we find the Creator arrayed against himself in all directions.'" In reply to this, it may be said, that an idea as commonly understood amounts to nothing as compared with the real which it represents, as a shadow is nothing as compared with the substance; nor is an inert body any more than a bare idea of much account to resist when subjected to a controlling exercise of physical force. In the actual world we find most results of any worth to be brought about by oppositions. That man, for example, will never amount to much in any walk of life, who does not encounter and skilfully and patiently overcome opposition. If the man do not encounter opposition, but glides along smoothly all through life, it is almost a certain indication that, at least, any good effects he may produce will not be wide-spreading. I do not here intimate that men should court opposition or that they should not rather avoid it; what I do mean to say is that if they pursue the line of their duty according to common sense and uprightness the opposition will present itself at times in the course of things, do

what they will to avoid it. If you go into a mill you will find all the cogs and wheels and all the mill-stones going in opposition to each other for the accomplishment of a certain purpose, namely, that of grinding. Will you say it was "Nature" that made each mouth a mill for the same purpose? In the individual human experience there is such an opposition of flesh to spirit that even a Paul finds it difficult always to obey his higher self.

There is an opposition in all things on and in the earth for the production of certain results in nature, and it is the opposite mutual attractions of the heavenly bodies that keep them in their uniform motions and invariably confined to their proper orbits. Now, no man will say it is the Creator that acts in opposition to himself, for the Creator is one and cannot be supposed to act against himself. No, it is the creatures, whether these be intelligent and free or otherwise, which act in opposition to each other, and very often, you know, the free and intelligent creatures act unwisely in such oppositions, as in the case of an unjust war carried on, or of two men trying to settle a disputed point and winding up in a mutual quarrel. Now, we can hardly think the Creator, who is infinitely wise, would act thus unwisely.

I think the foregoing argument must show the attempt to conceive of the Creator much more difficult than the idealistic theory as understood by some hasty speakers might leave it to be, and also show the idea of pantheism to be nonsensical.

The Creator being infinite, while omnipresent, is inconceivable; it is the creatures that are conceivable.

There are others, and very many too, I meet with them every day, who tell me they do not believe there is a God; they say they do not believe that anything but "nature" exists, and all *such* like talk. A man died lately in the state of Illinois who before his death had ordered that there should be no religious service performed at his funeral, only that they should consign his body to "nature" from whence he had sprung. This order was rigidly adhered to at the funeral, and in a short oration his body was consigned to "nature," his assumed mother. Now, when one speaks of nature one speaks only of created things as related to each other, for one can conceive only of created things as related to each other, but cannot conceive the real or unconditioned which is the substratum underlying and supporting the phenomena of the creatures. This real or absolute we may call the *Ego* or *Ego sum*, it is infinite, without body, parts or passions, beyond the recognition of our senses and inconceivable. Although all the creatures are related to each other and more or less independent of each other still they are continually dependent for their existence upon their

Creator who is also their substratum and supporter. The omnipresence of the Creator, notwithstanding the freedom and independence of each other of the creatures, which doubtless is for wise purposes, and which is real (for man is a free and responsible agent as all law assumes, and has great power given him over all other creatures), shows unmistakably that the phenomena of the creatures can only be, though in some way unexplainable by us, different presentations of the Ego to itself, or, speaking properly otherwise, *præsentationes differentes rationis universalis sibi*.

But what I have stated will help to show that men who say there is no God but "nature," rarely if ever understand or consider what they mean by nature. Even the contraries of up and down in the universe will show that when you are consigning the body of your friend to the tomb you know not but that you are at that moment putting him up on high, for I can prove satisfactorily to you that there is neither up nor down as regards the universe, whatever you may now think concerning it.

But to make the distinction in your mind between the Creator and the creature, I may say that in such case the body is returned to the dust from whence it came, and the spirit returns to God who gave it.

It may be again allowed me to suggest that theory should never be mistaken for science. As the theory of the origin of species and their growth through different modifications of form, some of which were wholly dissimilar to the present one, might be confuted by very simple facts, such for example as the presence of busy ant-communities in all quarters and countries of the globe, which could hardly be supposed to arrive at the same general state as to forms, habits, &c., in all these countries through different "modifications of form," or the "migration of species;" so, I think, the nebular hypothesis may be confuted, not only by all the phenomena of nature and the late discoveries of the telescope, but by the simple fact that one digs for water wherever he builds his house and rarely fails to find that fluid, which with many other fluids the Creator has made provision for in the earth's interior.

But, although science knows nothing as to the origin of the celestial spheres, nothing as to a beginning for their motions, nothing as to the origin of the terrestrial species, nor anything as to a destruction or annihilation of the universe, still, I think, we may be well content to leave all such like questions in the keeping of the Allwise, until it may please him to make other revelations to us concerning his Cosmos in such manner as pleases him, and to live in peace and love before him, always seeking to attain to the likeness

and righteousness of his son, in the manner set before us in the Gospels. Thus living, not only science but scientists will be reconcilable with religion.

All science is experimental or demonstrable by experiment. Religion is also in its way, experimental as is freely professed by most of the religious sects and sectaries. The science in which we are most concerned in the discussion of this subject, it is well known, is astronomy, and although this science is eminently an experimental one I think religion is, in its way, no less experimental. It is no proof against religion being experimental that scientists who have never fulfilled its conditions, or faithless professors who have no correct understanding of theology, say it is not. In the case of a problem in any experimental science certain conditions have to be fulfilled in order that certain results may be produced. In the same manner, speaking religiously, he that cometh to God must believe that God is, and that he is a rewarder of all those that diligently seek him by living a consistently Godly life. Now, he who has a correct understanding of theology has not a shadow of doubt in his mind that God exists, that the nature of God is to be just and good, and that, therefore, he is a rewarder of all those who seek him in truth and sincerity.

There are millions who will attest from their own experience the efficacy of prayer.

Prayer may not always be answered just in the way the suppliant expects or wishes, and yet it may be answered. Petitions offered up jointly by many for the same purpose are, according to the New Testament teaching, very likely to be answered, and hence one of the good purposes of religious associations. The people who pray, however, do not always keep sufficiently in mind that the nature of God is to be just as well as good: this thought as well as the thought of God's infinite wisdom should temper them in their expectations, and should make them content with whatever he sends them and with the way in which he sends it.

While the science of Astronomy fulfils its mission without giving any account as to the origin of the globes or of their motions, the Christian religion (that religion with which we are here most concerned) does not start out in this way, but exhibits in a book the account of its origin. The Christian system of religion was meant to supplant the old Jewish system as to everything, and it was introduced to the world somewhat after the manner of the former, at least so far as recorded miracles and moral obligations were concerned. In the New Testament, as in the old, we are of course to interpret literal language literally, and figurative language figuratively.

in order that the records may not contradict themselves, or rather in order to interpret them consistently with themselves.

Even if a fair and impartial critical examination of the four Gospels and the book of the Acts should prove those records to be in the main allegorical, or at least allegorical as to their main subject, their design would evidently yet be to show *the possibility of man's capableness for elevation to moral and spiritual perfection in holiness and Godlikeness, the real God-Man being seen set forth in the ideal.* Nor could the moral code set forth in these records be ever understood as any other than historical. *It is possible, however, that faith might find sufficient reason to accept the Gospels as historical by reposing itself upon the probability of a historical nucleus as the primary basis of the allegorical elaboration, even when the eye of the competent historical critic could not find sufficient reason to conclude them as being such.*

Paul may not have seen Jesus Christ in the flesh nor yet his literal cross, but the eye of faith in the firm believer, who reposes himself upon the supposed historical nucleus aforesaid, may perhaps see him even more clearly than the eye of sense could have done. Even faith, I believe, must have some base in reality in order to make it effectual. The competent critic may be at the same time eminently religious, and, if so, he will have a more definite, correct and, to him, satisfactory view of the God-Man, of his ascent in history, and of the literary character and object of the New Testament records than the unscholarly though zealous religionist may be expected to have. The church is always the realm of faith, and the profession of a reasonable, religious, and holy faith, provided it be such, is always accounted legitimate.

The religionist almost always understands the creation "in the beginning" to have reference to globes of land and water; rarely suspecting that the Heavens and the earth which were created may rather have reference to the church and those without its pale which were "in the beginning" of moral order in certain communities or nations established. He never does, however, think of accounting for the origin of the space which those globes occupy and revolve in. Perhaps our modern evolutionists, who appear to be full-fledged fowls now-a-days soaring high above all old modes of thought or forms of belief, would inform us whether, whence or when space has been evolved. This doctrine of evolution, it appears to me, will not stand in the case of an evolution of the celestial bodies or of their motions or of the space they revolve in; it can only assert what we all know, namely, that change is continually taking place in the material universe. It appears, however, to make better head-way

from its research in geology in accounting for the upgrowth of the terrestrial species. Mr. Darwin, however, went considerably too far in the particular of his zig-zag ancestry for man. By the term religionist I mean no disparagement of any particular mode of thought or set of opinions. I use that term in the same way as I would use the term Scientist or any other good English word. Men are of slightly different constitutions of mind as well as of body : we scarcely can account for or be supposed to understand each the other's daily spiritual and mental experience: if men find comfort and joy in certain modes of thought and tenets of belief, even if, in my opinion, their understanding of the matter be not altogether correct, I would be sorry to deprive them of the source of their joy if I could not replace it with a more intelligent and satisfactory source or cause of rejoicing and comfort. Such an one believes such a thing to be so because his Bible tells him it is so, and he finds comfort perhaps in his belief without attempting to rack his brain with critical investigations as to meaning. It may be possible, however, to give an interpretation to the passage different from that which he gives it, which may satisfy him better and be more correct.

Astronomy takes the Cosmos as it finds it to be and carries out its purposes by means of the laws which it has deduced as to how nature is and acts. True religion takes the records concerning the creation of the world and the founding of the old and the new Church as it finds them and considers them amply sufficient when rightly interpreted to meet the spiritual wants and requirements of mankind. The records of the Old and the New Testament are there and have their proper meaning whenever it be discovered, notwithstanding the opinion or act of some critics, who when they do not find them or portions of them to be historical throw them aside as having no meaning ; nor is there one of their recorded miracles, even if these should be considered of literal interpretation, half so miraculous as is this inexpressibly wonderful universe with which we are surrounded.

Man is born with a religious instinct within him, and the after contemplation of his own being and of the great universe which surrounds him increases and heightens the religious sentiment. True religion has as firm a basis to rest on for the belief in the existence of an omnipresent, omniscient, just, and good God as has Astronomy or any other of the experimental natural Sciences for the validity of its claims. The intelligent and true religionist does not trouble himself much as to the question of the origin of the material universe much less as to that of its destruction ; but having become satisfied

of the meaning of the sacred records which generally (I will not say always in particular cases) has reference to the world of mankind or the moral world rather than the material, he is assured that the *second birth* or the new creation by regeneration of the heart and of the life spoken of in "John" is a much more important subject of consideration for him than any possible creation of a material world is there considered to be.

Sir Isaac Newton, the principal founder of the Science of Astronomy would be a fair exemplar for scientific men to follow in regard to their estimation of religion. He lived the life of a self-denying godly man, wrote some on religious subjects, and died a sincere believer in religion. Religion was with him an experimental matter, and the pure Science of theology was by him, I believe, in his old age, pretty fairly understood.

The name of Gravitation is a name arbitrarily but properly enough given to the principle which attracts, but who has ever understood or could conceive that principle? The phenomena of the creatures, their different degrees of freedom and independence of each other are recognized, but the attraction of gravitation attests and illustrates the omnipresence and omnipotence of Deity. The condition and actual existence of antipodes illustrates the fact that the subject of Astronomy is as little fit to be ridiculed as is that of Religion. Religion and Astronomy alike defy the sneer of the Sophist and the worldly-wise.

The universal instinct and sentiment in man declares in favor of religion and demonstrates the validity of a lively faith in the benevolence and beneficence of the invisible and omnipresent Deity. This universal religious sentiment may be formulated into creeds and confessions of faith, or it may exist lively in the breast of the individual who does not profess or recognize any creed. In order to be truly religious it is not necessary that one profess a Pharisaic cast-iron creed, but it is necessary that one live a consistently godly life. Charity suffereth long and is kind: Charity covereth a multitude of sins: Love worketh no ill to his neighbor: Love is the fulfilling of the law: Do justly, and love mercy, and walk humbly with thy God, are all good mottos to be remembered and practised.

It appears to me that people of different sects or of the same sect, or even Scientists and Religionists, or professors and non-professors of religion should never grow angry with each other, more especially concerning any religious question. Religion is no fit subject to become angry about, and the religious history of the past, if men have not read it amiss, should warn them against harboring a malignant and bitter spirit in religious questions, and incite them to the culti-

vation of the spirit of meekness and sobriety, and to the practice of the life of active godliness, which is that also of true manliness, indicated in the New Testament.

If religion consisted in names and creeds it might often in the past have been inquired "Is religion reconcilable with religion?" when the different Christian sects were so violently opposed to each other as to seem to forget that they were all but different branches of the same Christian trunk. True religion, however, does not stand in the names of sects or of leaders, but it is a thing of the spirit, of the heart, and of the daily life, and consequently there is but one true religion and that the same in all sects, and non-sectaries. Now, as God is one and cannot be supposed to contradict or oppose himself, so true religion, being one, cannot act in opposition to itself. When, therefore, we hear of a religious war, a religious quarrel, religious rancor, or theological pride, we hear nothing at all about true religion, but about a spirit and a life diametrically opposite to it.

True religion, therefore, being of such a simple nature as I have indicated, cannot contradict Science, for even Scientists may be true Religionists; and its fruits distinguish it wherever it exists.

For the mutual help and advancement of society religiously, organized religious societies are found to be the most effectual means. It would be difficult to find unanimity in any assembly with respect to any given subject, arising from different degrees of education and different habits of thought in individuals, and, therefore, in a religious association it has been found better for the individuals to exercise a mutual forbearance and condescension toward each other. One should not consider that he is descending from any dignity if for a mutually good understanding on any subject one condescends to give or receive explanation. Some there are who have a distinguishing peculiarity of inquiring from others their religious opinions, especially as to particular points of belief or doctrine as they call it. Such inquiry is for the most part simply to gratify the curiosity of the questioner, and when they become impertinent or insolent in their questionings they may well be dismissed without having their curiosity gratified with an answer. After a few such dismissals they will likely begin to learn better manners, and nobody can fairly sympathize with them in their disappointment since, as with a pettish child, the course thus taken with them is for their good. This has no reference to a fair question which in general deserves a like answer (although in ordinary cases it need not be answered if one does not wish), but one's private opinions or understanding of religion one should not be pressed to communicate against one's will. In an organ-

ized religious association the pastor is, of course, supposed to be more clear on all religious subjects than those of less extent of theological learning than he: it is reasonable, therefore, that he be guide for his time.

Of all the systems of religion upon earth there is none that I am aware of so well adapted for the moral advancement and elevation of mankind as is Christianity rightly understood. It makes mankind of all nations and classes brethren, removes all oppressive and burdensome superstition, inculcates the practice of humility and the suppression of pride, and teaches the simple worship of the invisible and omnipresent God in spirit and in truth. Such religion is, therefore, a religion of the heart and of the every-day active life, it has been designed, for mankind worldwide, is so universal in its application as to meet all their spiritual requirements, and fulfils the conditions of the Science of theology so far as can be fairly claimed of that Science. Such being its nature, design, and scope any diligent student of history or observer of his own times can see approximately how far its spirit and design have been departed from in certain ages, nations, and systems since the period of its first promulgation, and how necessary it is that a more general practice of its spirit and its precepts be cultivated among mankind. As I have before remarked the democratic spirit of the free American institutions has liberalized the narrow and exclusive religious sentiment of the world, and these institutions have it in their power to go on doing good in the same direction. Within the borders of the United States the Christian Sects though numerous have of late years been at peace with each other, and as far as I know their ministers may consider themselves as working for the same great end in slightly different ways, namely, for the moral and spiritual advancement of mankind.

There are, also, in this great country very large numbers of good-living, intelligent people who do not profess the Christian religion, nor a religion of any other name, perhaps, because they consider these religions as erroneous and burdensome. While believing that it is better for all to observe one day in seven for rest and for the worship of God in public, I have long since discarded the notion that the attending church does of itself make one either more or less respectable. They that would put on the name of religion as a cloak to cover their worldly designs of avarice and ambition, while not evincing the least degree of the spirit and love of God in their life and conversation, would wish no doubt to be deemed respectable as well as religious while they really are neither. The object in attending church should be to worship God in spirit and in truth in that place especially set apart for his worship. If one goes to the house

of God actuated by worldly or secondary motives it would be decenter and more manly for him to turn his steps to some other place or to remain at home.

I do not consider it my mission or consistent with my dignity as a scholar and a gentleman to insinuate any invidious distinctions between the sects of Christians by an independent criticism of each or a comparative estimate of their standing or merits; but I do think that (consistently with the living up to the moral precepts of the Gospel and the keeping the ideal head of the Church in view as a guide, directing men forward and upward, and as an exemplar whose lessons and practice of self-denial and active godliness are to be followed, even to "the crucifixion of the flesh with its affections and lusts," and in this sense as a Saviour, rather than as an unapproachable earthly monarch or as a Deity whose perfections it would be presumptuous and superfluous in mortals to attempt to imitate,) that the broader and freer, I say, the principles of the church are made both as to a consistent Gospel interpretation and otherwise, and the more intelligently humble and condescending its ministers, the greater advances will it make and the more effectual work will it accomplish in this country and age. Such is, I believe, the way in which the Christian sects, both Catholic and Protestant, may be unitized for their common good and for the good of mankind, for whose salvation they can then join their efforts. Is it any wonder that Scientists should sometimes be found who would find fault with religion when religionists of different sects are so prone to find fault with each other? It is past the time when ministers or leaders of sects would lose any self-respect by stepping forward and proposing to unite with their contemporary sects on the broad principles of a free and consistent Gospel interpretation. What endless series of sermons might be preached, and what numbers of excellent books might be written, upon the subject of man's capacity for infinite improvement, and on the probability of his capableness for advancement and elevation to moral and spiritual perfection as represented in the ideal head of the church, his elder brother so to speak, which sets forth his own real advancement and elevation if he will. The Bible, rightly interpreted, is a sufficiently broad basis for Christians to come together upon, and it is sufficiently ample and many sided in its adaptability to meet the religious requirements of all who will have it or to whom it may be applied in all ages.

*Liberty and Its Limitation as to Action and Investigation of Cos-
mical Phenomena: Human Languages, Their Origin, etc.*

Liberty is the natural birthright of man; liberty to think for one's self; liberty to act within the limits of morality and law, and liberty to investigate the subjects in which one may be or may become interested so far as one's means and opportunities allow. Education completed leaves the mind better able to distinguish spontaneously as to the propriety, the what or how, when and where of liberty of action. The educated mind, too, is generally forward in its action; I say generally, for there are occasionally among us some lady-like educated males who rather incline to follow than lead, and are exceedingly nice in what they say and do. I know some such; perhaps they may be termed æsthetics, and perhaps, too, we have need of a slight sprinkling of such characters among us to help mollify the masculine temper of our practically educated and rough republicans. This new country will, however, yet for a long age demand in its people a masculine and enterprising spirit, and by the time we have all our territory as well cultivated as England, it will be time enough for us to begin to run wild after the "utterly utter" European æsthetics. But extremes do meet everywhere; for I remember what a professor in one of the colleges I attended used to say to us, namely, that it was better for a young man to have a thorough drill in Greek, suppose he should spend his whole after-life in pulling stumps. But in saying this he had, doubtless, at heart the true interest of the boys and of the country; for that is an Eastern college, in which the students then, imitating English customs, were accustomed to wear the triangular-crowned Oxford hat and the black gown. My own personal tastes did not incline me to don these appendages, nor did I think them consistent with the democratic simplicity which, in my idea, should characterize an American institution of learning, wherein the youth should be prepared to be rather useful servants and benefactors of their race than to be lords over their fellow-countrymen. Now liberty, as well as the genius of republican simplicity, says that a boy may study Greek, mathematics and logic, and may perform agricultural labors or any other honest toil, with credit to himself, the object being the good of himself and his race. Nor do I know of any limitation to liberty of action in such directions unless we proceed to take into account, which would be an endless task, the

accidents of life, say, for example, the dampening of the ardor of some young agricultural æsthetic home from college, when caught in the act of manual labor on the farm, in his shirt sleeves, engaged in extracting stumps, in hoeing a drill, in weeding a plat, or in driving a cart, by a scholarly gentleman of his acquaintance of great means and leisure coming the way in full dress, to whom he might suspect such employments would appear *infra dig.* But such accidents of life are hardly necessary to trace or mention, at least in the present general condition of society in this whole republic, for the minds of the people in general are so moulded, and their habits so formed, that each one spontaneously chooses for himself his course of honest toil in some department of labor, and, while engaged in it, deems it as respectable as the balance of the employments. Nor do I think this normal and generally healthy condition of the American mind is likely to be soon in any great measure changed towards European or Asiatic caste idea, at least so long as our common schools and institutions of learning generally are doing their work so thoroughly throughout the republic, and so long as we have in the mothers of the republic the ideas of New England and of the Old Dominion.

Now, as I have stated, liberty to think for one's self is the natural birthright of man, even though it be denied by prince or prelate, so also is liberty of action within morality and law, and a proper self-direction and control makes action within morality and just law all that is to be desired as to liberty of action. But, moreover, liberty to investigate the subjects in which one may be or may become interested, as far as lies in one's power, also belongs to man. Slavery is the opposite of liberty, and mental slavery is the most abject, or, I should say rather, the most effectual kind of slavery; for as the body follows and obeys the mind, the mind being in subjection, the body is languid and spiritless. Servility of mind is indicated in every feature, and it is quite impossible for the mind, remaining servile, to mentally improve or strengthen itself or other minds. Hence it may appear important that, while being educated, the minds of some children and youth who are naturally timid should not be rendered servile by their being made unnecessarily to feel too cheap betimes. And the time may come when, after the manner of the Roman republic, this republic at large will say: "No American citizen shall be punished by flogging." It was by their being possessed of no servile spirit that the Roman republicans conquered the world; but when the servile spirit came in with the

empire—the emperor being *pontifex maximus* of that imperial-sacerdotal system—Rome did not long remain unconquered, and her sons became the most ignorant, superstitious and abject of slaves. True manliness is always united to true godliness; education, properly conducted, conduces to this; but when the church and state become combined in government, and the priests become civil magistrates as well as being ministers of religion, the effect upon the mental, moral and physical character of the people exhibits itself as the generations pass on in increasing helplessness and servility, so that there are left only a few living men—all the rest are chattels. We do not want such a state of things here, and should at least give our moral support to others who wish to rid themselves of such an incubus. Hence is seen the necessity of educating the people to think for themselves, so that each one may be a unit in society and regard himself or herself as a responsible being, accountable to themselves and to the whole community, and having a glorious destiny to work out for themselves. The idea of class distinctions the American educator should never countenance, much less inculcate; nor will he, unless, perchance, he wishes insidiously to do his part to resolve the nation from a democracy into something similar to monarchy, which would be so abhorrent to equality and liberty and to human and divine right as to be intolerable.

Dr. Samuel Clarke justly says: “A free and impartial inquiry after truth, wherever it is to be found, is indeed a noble and commendable disposition; a disposition which every man ought himself to labor after and to the utmost of his power encourage in others.”

Now, the liberty pertaining to man to investigate the subjects in which he may be interested, permits him to investigate subjects concerning which there is no actual knowledge, as, for instance, the origination of existing things, and states or conditions of things, and phenomena. He has liberty to pursue such investigations, which he may do with pleasure and profit to himself and to humanity, and without giving proper cause of offence to God or man, his object being to discover the nature of the things, the time and manner of their genesis, the progress and nature of their changes, etc. Now, such a great object of investigation we have in the cosmos, and in each and all of the departments of its phenomena. With respect to the cosmos in general, you, my friends, will agree with me that it should be for all a subject of great and

varied interest to inquire into the nature and character of the phenomena. The rotundity of the earth, which is not a direct object of our senses, but is capable of so many irrefragable proofs that it stands in our mind as if it were such sensible object, and the fact that all antipodes have identical impressions as to the cosmical phenomena, is, however, sufficient to convince any reasonable and reflecting mind that the perceptive faculty, the real soul or self, is without limitation, and absolute, the perceived ideas or impressions, even as to the immediate environment of the ego, being finite, relative and phenomenal. This, when understood in the consciousness, which is the strongest and most satisfactory of all proofs of what is to be understood as the supernatural, leaves the belief in the existence of God and the resurrection of the body a most easy matter, does not by any means abridge the full idea of human liberty within morality and law, nor affect the idea of the substantial reality of the cosmical existences; for life's experience, the deductions of reason and divine revelation prove alike the phenomenal and the real; the sensations of pleasure and pain being classed as ideas, or rather impressions, under the phenomena of feels. The Creator, in His wisdom and power, has so constituted us for our place of abode as not, by our senses at least, to be conscious of an antipodal existence, nor of the motions by which we have the alternations of day and night, and the seasons. The terms "up" and "down" have no reference to absolute, infinite existence, but they relate primarily to the poles of the human body, considered as standing erect, the head being up, and the feet down. And in this connection also, we cannot fail to notice the controlling and limiting power of the Diety, and together with His omnipotence, His omnipresence and omniscience; for, if He be omnipresent—as the Church of England broadly asserts, as indeed all churches assert, and as is true, independent of all their assertions—He must be omnipotent and omniscient, the one of these terms implying in itself the other two. But with a certain writer and divine of a past age, I see the character and power of Diety manifested rather in the regular order of nature than in the character of man, and here you perceive his exponent is reason.

As concerning man in relation to his Creator, whether he be a free moral agent or a predestined being, there has been, on both sides, much said and written; and, although there is truth in both positions, yet it may be said that if the Creator has predetermined

the lives of human beings, He has in His wisdom and goodness so constituted their nature, both as to themselves individually, to each other, and to the constitution of nature around them, that they all believe themselves to be free moral agents, so far at least as that they are accountable for their own voluntary acts, which must include their course of conduct as to performing and omitting duties. Bishop Butler, in his "Analogy," part 1, chap. 6, says: "The constitution of the present world, and the condition in which we are actually placed, is as if we were free. And it may, perhaps, be justly concluded that since the whole process of action, through every step of it, is as if we were free, therefore we are free."

The reducibility of all the elementary substances to a simple, which I believe was proved theoretically by J. Norman Lockyer (although I have not yet seen any treatise which he may have published on that subject), I had clearly in my mind and had made plain in print before I had heard of Mr. Lockyer. It is a conclusion at which the mind arrives before proceeding far in a systematic investigation of the cosmical phenomena — indeed, as the idea of liberty it is, I may say, inherent in the mind.

Now the omnipresence of Deity, taken together with His omnipotence and omniscience, proves beyond contradiction the existence of the external world, for experience shows that the world exists, and the reason of this is that the Being who is omnipresent, omnipotent and omniscient, can will and execute anything he pleases. He can create existences of infinite character and variety, and can adapt infinite means to ends in the production of beings for different purposes and ends in the universal economy. And He can create beings without sense and intelligence, and beings with sense and intelligence, in inorganic and organic existences; and in the highest species and orders of beings, visible and invisible, He has produced, He still can create to will and to do of His good pleasure. In the consciousness of the existence of such a Being, creation presents to the mind no difficulty; nor how the infinite variety of created existences depend on the will of the supreme *Ego Sum*. We, therefore, perceive the existence of the cosmos, and as certainly perceive the existence of the Creator, omnipresent, omnipotent and omniscient, for if the former exists, as reason and experience prove it does, so does the latter; and if the latter do not exist, neither does the former. Now the most ignorant man will tell you emphatically that the world exists, and you believe he means what he says, for he has at least

what is called the material conception of existence, and of the world ; and, on the other hand, the most intelligent man, especially if he be well versed in science, and have been born of the spirit from above, and have systematically and rationally investigated the phenomena of the cosmos, will tell you as emphatically that not only the world exists, which every one spontaneously confesses, but that also the Creator exists. The latter will also admit not only that all the operations of nature, such as the rising of the tides in the ocean, the upgrowth of animals and plants, and the expansion of the air about the earth, contrary to the earth's attraction, proceed according to definite laws, but also that they are according to the will of this Supreme Being, His will being law ; ■ Being who has so arranged and constituted these things that the fourteen tons weight of air, which theory has imposed on the body of each man, as well as the motions of the earth and the heavenly bodies, should pertain rather to general theory than to sensible individual experience. The latter, whom we will now style our Christian philosopher, is not troubled about the so-called "contradictions in science," especially as to astronomy. In the first place, he has in mind that the science of astronomy does not pretend to account for the origin of the celestial spheres, or of their motions, but that taking all these as it finds them, it accounts well for the celestial phenomena. If, then, he be told that he has never seen the earth move, nor the moon perform a revolution round her axis, and that the action of the known laws of gravitation and of the descent of bodies towards the earth's surface on all its opposite sides necessitate that the earth as a whole, or any analogous co-existing body in space, be lighter than ■ feather, or have no weight, it will content him to answer that though he admits all this, that he never saw the earth move nor the moon performing a revolution round her axis, he has reason to believe if he were situated at a convenient distance outside of the solar system, where he could observe all its bodies minutely, he would see all the motions by which the phenomena are brought about accomplished with that regularity and precision which characterize them, and that these motions are governed by the attraction of the bodies for each other in proportion to their respective gravitations or weights ; it may not be exactly in the same sense as a man may be of "weight" in a community, but literally so, if his controlling influence in the community be as his literal weight. If he be told that the reducibility of all the elementary substances to a simple destroys the idea of the theoretical atoms, which

is the foundation of the science of chemistry, he will answer that this by no means follows, for that that simple can only refer to the principle which is the base of all, which the mind perceives independent of experiment, but the latter proves to the satisfaction of those who are willing and competent to follow out the demonstration. He will be strongly supported, too, in this position and assertion by the knowledge that all the forces of nature, light, heat, electricity, gravitation, magnetism and motion, are governed by the same law, which proves them to be modifications of the effect produced by one simple, primal agency; that while matter, which, if it be understood at all, is to be understood in the thought underlying it, is an effect of the Creator, these forces are, or may be called, effectuations of matter. He will fully realize that science, properly so called, and theology go hand in hand; that they may be profitably pursued in connection with each other, or that they may be pursued independently of each other, but that they do not contradict each other.

Now, with respect to the time of the first appearance of those cosmical phenomena which we experience, and how they have progressed as to changes, etc., and may go on to progress, might be worth a brief consideration, and is allowed us to investigate. In this investigation we have to depend mostly on the data which our own planet affords us in its pages of nature and history. From all that we can learn from the experience of men in the past, we have no good reason to conclude that the universe in general ever presented to the eye of man an appearance remarkably different from what it does now. The Chinese and Hindoos pretend that their astronomical records extend back to a prodigious, shall I say, to a fabulous, length of time, as is also inferred of those of the Egyptians, from relics of theirs which have been unearthed; but I have not seen that anything appears in these records, whether we deem them fabulous or otherwise, to show the phenomena of the universe in general to have been, in any past age, remarkably different from what it is now. When this phenomenon may have begun to exist, and when it may cease to exist, God only knoweth; but its existence in general does not depend upon the existence of man, as the wording of Bishop Berkeley, wrongly construed, might be thought to imply; for, if man ceased to exist from the earth (if that could be supposed possible), there is no reason present to our mind why the cosmos in general should not present the same general appearance (man being excepted from the phenomena) to the eye of a superior

being, or to the eye of a being in another planet, who was endowed with human senses, as it now presents to us.

Philosophy teaches that through the senses we acquire all the actual knowledge we possess of the external universe. For the phenomena which surpass our sensible experience we invent theories. At one time we prop up the heavens on the shoulders of Atlas or support the earth on the back of a tortoise; at another we remove both the props, and support and govern the earth by attraction and propulsion. Some have seriously considered, but we think to no purpose, whether the shoulder of Atlas and the tortoise would be preferable to the attraction and propulsion of Newton, if it would apply to a greater number of sensible revelations, or subserve a greater number of useful purposes. The senses, too, are independent of each other, each performing its own functions. We cannot, for example, taste a sound, see a feel, feel a sight, nor hear a smell, etc. Some philosophers have surmised that the addition of a sixth sense might add greatly to our knowledge, by discovering to us the nature and operation of our soul. Nor know we how man could be man without most or all of the senses. But, as it is, we are so constituted that there is also a universe internal to us of our consciousness, which also becomes known to us by sights, feels, sounds, tastes, and smells. Of this internal world I am at least as conscious as I am of the external world. During my spiritual life I have had continual experience of this internal world of consciousness, and when in the third heaven my internal senses were in such full operation, and my experience was such that (if I say it is inexpressible or unlawful to be uttered) I trust I will be excused from further explanation. Now, the information of each of our senses being philosophically considered a distinct existence, it is easily seen that language implies a oneness, to which nature conforms not in all cases: for instance, the word shadow, which is only a sight, implies a unit, as well as the word iron, which is a sight and a feel, or the word orange, which implies a sight, feel, taste and smell. Hence it is plain the true explanation of cosmical phenomena is to be derived from the direct information of the senses, rather than from the forms of language, for the natural oneness varies in different existences, while the verbal oneness of every existence is equally simple.

Bishop Berkeley perceived that the word roundness signified a sight and a feel. Not knowing that the duality of nature controls the oneness of the name, he supposed the oneness of the name

proved the duality of nature to be fallacious, and that either the sight is the true roundness or the feel. He decided in favor of the latter, and hence he concluded roundness to be invisible, because he restricted the name to the feel. Locke and his class of philosophers have selected the feel as the proof of the external world.

Rees's Cyclopedia records a sudden acquisition of sight by a person who had been always blind. "When he had learned to distinguish bodies by their appearance, he was surprised that the apparent prominences of a picture were level to the touch." The experience of this person is adduced by the Cyclopedia to show that the senses are fallacious; hence the person is made to ask which sense deceived him. Neither sense, however, deceived him. The sight prominence and the feel prominence are so generally associated that we expect the feel where we see the sight; but they are distinct phenomena, and may be separated, as the illustration shows. But if we suppose that they are invariably associated, the mistake is in our inexperience, and not in our senses, nor in nature. This shows that we should make nature, or the direct information of our senses, the expositor of language rather than make language the sole expositor of nature.

Says Dr. Reid: "When I look at a book it seems to possess thickness as well as length and breadth; but we are sure that the visible appearance possesses no thickness, for it can be represented exactly on a piece of flat canvas." The painting exhibits the sight thickness without the feel, and thickness being restricted to the feel, the sight thickness is pronounced a delusion. The feel thickness and the sight are equally realities of the external universe. We may, if we choose, restrict the word to the sight, and assert that the feel is a fallacy, but nature is no party to our philology. She exhibits her phenomena just as our senses discover them to be, unaffected by our theories and unchanged by our phraseology.

"When I touch a stone," says Prof. Beattie, in his essay on Truth, "I become conscious of a certain sensation; but this sensation is not hardness itself, nor anything like hardness; it is nothing more than a sensation or feeling in my mind, accompanied, however, with an irresistible belief that the sensation is excited by the application of an external and hard substance to some part of my body." Now, what is this sensation? It is just what it is. Language will be likely to mislead us as to it. We shall best understand the natural meaning of the word hardness by dispensing with all language and accepting as a signification the mute revelation of

our senses, so that a deaf mute may understand what hardness is as well as we.

What is conscience? The dictionary will say, "the faculty by which a man judges of the moral qualities of his own actions." But conscience is not these words. It is what I experience within myself; and if I experience my mind to be unlimited, to be intimately present everywhere with the objects of which I think, that it is co-extensive with and circumscribes all ideas, this is included in my conscience or consciousness.

Says Dugald Stewart: "The assertion of Berkeley, that extension and figure possess merely an ideal existence, tends to unhinge the whole frame of the human understanding by shaking our confidence in those principles of belief which form an essential part of its constitution." What serious consequences from the use of a new phrase? If we consider the language of Berkeley as merely a designation of sensible information, his phraseology will be unimportant. We may call extension and figure either ideal existence or material existence, and our language will mean simply what we see and feel. If, however, we use language for the purpose of deducing consequences from names, the phraseology may be important, but the importance will arise from ignorance of the nature of language.

Prof. Stewart again says: "In consequence of the writings of Reid and a few others, the word idea itself is universally regarded as a suspicious and dangerous term, and it has already lost its technical or Cartesian meaning by being identified as a synonyme with the more popular word notion." Philosophy is here improved by simply substituting the word notion for the word idea. And why? Because the verbal consequences which we deduce from the word idea cannot be deduced from the word notion. The change of phraseology is an improvement arising from ignorance of the nature and use of language.

Concerning the manner of our perception of external objects, Dr. Reid discarded the old ideal systems, finding it was just as difficult to explain how our perceptions are acquired by the intervention of what are philosophically called ideas, as it would be upon the supposition that the mind is present with the objects of its perceptions. As it is a maxim that nothing can act but where it is, so the mind can perceive no object except it be present with the object. On this ground proceeded, also, M. Victor Cousin, in his able "Analysis of Locke's Essay." These conclusions, however, of Reid and Cousin do not at all invalidate the effects of the operations

of our senses, for, according to the constitution of our nature, certain sensations are rendered the constant concomitants of our perceptions. All, I apprehend, they invalidate is the theoretical picture of the external object imprinted on the retina, "as the impression of a seal upon wax," by the organ of sight, and which some ingenious philosophers have represented to be inverted, so that we might conceive it somewhat as of the picture of a man suspended on a gibbet, head downwards. A man is satisfied of the existence of the moon, and sits in his chair and makes it an object of his thoughts. Neither its near surface, its centre, nor its opposite side can limit his mind. His mind comprehends it literally with as great ease as it comprehends a billiard-ball or a pin's head. So Jupiter, the nebula of Orion, all worlds and universes, are comprehended in the *mind*, and do not begin to limit its power of conception, and, in this sense, there is nothing to the mind external.

Says Dr. Clarke, in a letter to Leibnitz: "Without being present at the images of the things perceived the soul could not possibly perceive them. A living substance can only there perceive where it is present. Nothing can any more act, or be acted upon, *where* it is not present, than it can *when* it is not." Dr. Porterfield, in his Treatise on the Eye, says: "How body acts upon mind, or mind upon body, I know not; but this I am very certain of, that nothing can act, or be acted upon, where it is not," etc. These two authors were attached to the ideal theory of Locke, which, as commonly understood, represented the mind as an unextended substance shut up somewhere in the brain (as we might conceive a prisoner in his cell whose only callers were his own ideas), and which, contrary to reason, as it must appear, supposed that the images of extension and figure can exist in an unextended substance. But the mind is unextended in the sense of being infinite, in which it circumscribes the ideas of all existences. It is unextended, therefore, in a reasonable sense, in which it really comprehends all extension. The words of Victor Cousin, as applied to the infinite Deity, are applicable to the mind, "He is less than the least and greater than the greatest," *i.e.*, He or it is incomprehensible. The principle, however, holds that nothing can act, or be acted upon, but where it is present; nor is the mind such a prisoner as the "dark closet" of Locke would imply, but it is infinite, all-pervading, all-penetrating, and, being absolutely free, is a prisoner nowhere.*

Says Prof. Stewart again: "A moments' reflection must sat-

* Let me add to what I have said that mind is, nevertheless, to be considered as an unextended, indivisible substance, the ideas it hath of extension, figure, etc., being modifications of itself; and its power of recalling the past and forecasting the future being termed respectively remembrance and anticipation.

isfy any one that the sensation of color can reside in a mind only ; yet our constant bias is to connect colors with extension and figure." The sense to whose information is here referred the word "connect" should be discriminated. If we refer it to the feel connected, such as the feel we experience in the links of a chain, it is nonsensical to assert that color is not connected with external objects. Color is a sight ; hence it cannot produce the feel to which we refer by the word connected. Color exhibits the sight connected, which is the only connection applicable to colors.

He adds : " But our natural bias is to conceive white, blue, and yellow as something spread over the surface of bodies." But Mr. Stewart does not here tell us the sense to which he refers. We admit that oil and paint can be spread over the surface, and this elucidates the matter, for we refer to the feel "spread over the surface." But when we say color is spread over the surface of bodies we allude to the sight spread and the sight bodies. Prof. Stewart did not intend to quibble, but he did not sufficiently distinguish the chameleon character of words.

"In the same way," he again observes, "we are led to associate with inanimate matter the ideas of power, energy, and causation, which are all attributes of mind and can exist in a mind only." I confess that this does not appear to me to be a very wise statement of Prof Stewart ; for, if we associate causation, and all that it implies, with what is vulgarly understood as inanimate matter, we simply associate it with a bundle of sensible qualities, ideas, or impressions ; for all philosophers, including Mr. Stewart, confess that all which we can possibly know of matter is its sensible qualities. The subject or substratum of those sensible qualities is from the cause which makes us perceive them ; which cause createth, manifesteth, sustaineth, and worketh all in all to the creatures, but is itself incomprehensible.

The causes which produce the general effects in the changes of nature, and which man cannot account for unless by theory, are called metaphysical or efficient causes. Those which produce the effects which he supposes he can account for are called physical causes. Now, there is no physical effect which man thinks he can account for more satisfactorily than motion by impulse—for example, of billiard balls ; but that this is not understood will appear from what follows : "Some of the ablest philosophers of Europe," says Stewart, "are now satisfied not only that there is no evidence of motion being in any case produced by the actual contact of two

bodies, but that very strong proofs may be given of the absolute impossibility of such a supposition; and hence they have been led to conclude that all the effects which are commonly referred to impulse arise from a power of repulsion, extending to a small and imperceptible distance round every element of matter." — "The communication of motion by impulse is as unaccountable as any phenomenon we know, and yet most men are disposed to consider it as a fact which does not result from will but from necessity." We should judge that the motion, where it does exist, arises both from will and necessity, for causation certainly pertains to will, and, where the controlling will is for motion, there is the necessity of the motion. The following observations are from Mr. Locke, book 2, ch. 23, and are well worthy of consideration: "Another idea we have of body is the power of communicating motion by impulse, and of our souls, the power of exciting motion by thought. These ideas — the one of body, the other of our minds — every day's experience clearly furnishes us with; but, if here again we inquire how this is done, we are equally in the dark. For in the communication of motion by impulse, wherein as much motion is lost to one body as is got to another, which is the ordinariest case, we can have no other conception but of the passing of motion out of the one into another, which I think is as obscure and inconceivable as how our minds move or stop our bodies by thought, which we every moment find they do." — "The communication of motion by thought, which we ascribe to spirit, is as evident as that of impulse, which we ascribe to body. Constant experience makes us sensible of both of these, though our narrow understandings can comprehend neither." — "To conclude, sensation convinces us that there are solid, extended substances, and reflection, that there are thinking ones. Experience assures us of the existence of such beings, and that the one hath power to move body by impulse, the other by thought. If we would inquire farther into their nature, causes, and manner, *we perceive not the nature of extension clearer than we do of thinking*. If we would explain them any farther, one is as easy as the other; and there is no more difficulty to conceive how a substance we know not should by thought set body in motion, than how a substance we know not should by impulse set body in motion." Says Dr. Barrow in his "Mathematical Lectures" at Cambridge: "If we except the mutual causalty and dependence of the terms of a mathematical demonstration, I do not think there is any other causalty in the nature of things, wherein a necessary consequence can be founded.

Logicians do, indeed, boast of I do not know what kind of demonstrations from external causes, either efficient or final, but without being able to show one genuine example of any such; nay, I imagine it is impossible for them so to do," etc. Hobb's, in his *Tripes*, says: "When a man hath so often observed like antecedents to be followed by like consequents, that whenever he seeth the antecedent he looketh again for the consequent, or when he seeth the consequent maketh account there hath been the like antecedent, then he calleth both the antecedent and the consequent signs of one another." Says Bp. Berkeley in his "*Inquiries Concerning the Virtues of Tar-Water*:" "The words attraction and repulsion may, in compliance with custom, be used where, accurately speaking, motion alone is meant." — "Attraction cannot produce and, in that sense, account for the phenomena, being itself one of the phenomena produced and to be accounted for." — "Instruments, occasions, and signs occur in, or rather make up, the whole visible course of nature."*

If we could, in any instance, perceive the manner in which a cause produces its effect, we should be able to deduce the effect from the cause by reasoning *a priori*; but this, according to the ablest philosophers, from Lord Bacon to the present time, is a thing impossible. But a consideration of the above excerpts, from some of the profoundest reasoners on cosmical phenomena, coupled with a knowledge of the constitution of human nature and of the human mind, will help to the general conclusion that, although all causation is really referrible to the metaphysical or efficient, which pertains to spirit, mind, or will, and is not an object of our senses, yet the classification of causes into metaphysical and physical, which you may be pleased to term primary and secondary, is for the convenience and benefit of mankind, his nature and circumstances being considered; for, besides appearing according to nature, it answers the double purpose of, firstly, enabling us to prosecute the arts and sciences in our systems of education and general utilization on a demonstrable basis of common sense, without any inconvenient metaphysical idea necessarily or ordinarily invading the mind; and, secondly, to organize and operate to perfection and completeness our systems of law and of government. And, thus, when I consider the constitution He has given to nature and to the human mind, I have no doubt it was the Creator's design that such a distinction as of metaphysical or efficient and physical causes should be made; for, as I have shown elsewhere, the re-

* To line seventeen from top let me add Dr. Reid who says: "Effects and causes in the operations of nature mean nothing but signs and the things signified by them." Peruse Hamilton's notes in connection with Reid's works.

quisite knowledge for mankind, considering his general character and nature, is what is usually termed "common sense."

Says Dugald Stewart, in a foot-note to Vol. II. of his works: "When I speak of Reid's *asserting the existence of matter*, I do not allude to any new proofs which he has produced of the fact. This he rests on the evidence of sense, as he rests the existence of the mind on the evidence of consciousness." Reid claimed to have refuted both Berkeley and Hume, who had both, at least ostensibly, taken that theory as the basis of their demonstrations. Prof. Stewart, however, entertained a very favorable opinion of Hume's doctrine, which he concluded to be "theistic, in that it kept the Deity always in view, not only as the first, but also as the constantly operating, efficient cause in nature, and as the great connecting principle among all the various phenomena which we observe." (See note D to Vol. I. of his works.) But it is evident that between the doctrines of Berkeley and Reid, the difference could rather have been verbal than real, arising, I think, mainly from the former having used the word *idea* in two senses: first, in the sense of *idea proper* — *i.e.*, an impression made on the mind through the senses; and secondly, in the sense proper of thing or existence. Matter or body, in its infinity of manifestations, may be perceived in the sense in which I have elsewhere illustrated it, namely, as being modifications of spirit, literal or real. But matter, in the vulgar sense, or considered as made up of invisible atoms or infinitely divisible particles, no one should trouble himself about. It is, doubtless, the Creator's design that we be content with our research into the nature of matter when we shall have arrived at the *minimum sensible* particle, and have discovered by our senses its qualities.

"Nothing is in sugar," says Locke, "but a certain texture of parts, which are so formed as to produce in our organs of taste the sensation of sweetness. Sweetness itself is not in sugar." But Locke does not inform us the sense to which he refers for the signification of "in." If he refer to feeling, sweetness is, of course, not in sugar. No man believes that he can feel sweetness in sugar. Sweetness is in sugar when we refer to the sense of tasting, for the signification of the word *in*, and no other sense possesses any cognizance over the subject.

The fragrance which I smell in a lily, is it in the lily or in my mind? We must ask the senses: they alone can answer the question. What says feeling? He will feel all that is in the lily, such as texture, substance, figure, etc., but he cannot feel fragrance.

What says seeing? It can see all that is in the lily, but it cannot see fragrance. We may, with like result, ask tasting and hearing. They will severally affirm that they can taste and hear all that is in the lily, but they can discern no fragrance. When, however, we ask smelling, it can discover fragrance in the lily. The "in" must refer to the information of this sense. To ask whether fragrance is in the lily — meaning the feel in, the taste in, etc. — is to talk absurdly.

Now, although our sensible knowledge of the universe external to our own planet consists in sights only yet from analogy, from telescopic and spectral-analytic information, etc., we believe that were we present at each of these distant worlds — say at the sun, moon, planets, etc. — we would be enabled to experience variously the feels and all the other sensations implied in the sights.

But drawing in our thoughts from the general universe, and fixing them upon our own planet, we find proofs in the geologic strata of this earth having existed for a prodigious length of time. In considering this subject the rotundity of the earth should always be borne in mind, and that, for this reason, the material which forms the different strata must have, in the case of the strata in each locality, come from somewhere near by, for the geologic stratification is found on all the opposite sides of the sphere. The material, therefore, which forms the strata pertained to this sphere itself, and the different strata we take to be the same material differently existing. Some of the exponents of the doctrine of evolution, who take for their base the now long-exploded nebular hypothesis, conjecture for us an infinite series of evolutions and dissolutions of the forms of matter, which, referring to the phenomena of the general universe, implies an infinite series of cosmos. This being to us as infinite space or infinite time, without beginning and without end, is as no-thing, no-idea. Perhaps they have found some reason for their limitless idea in the Brahminical periods, the Kalpas and pente Kalpas of the Hindoos, without giving due consideration to the other Hindoo idea of heaven and earth having come forth from a bursted egg.

Would it then be as well for us to adopt the idea of the probable permanency of the cosmos in general as to forms, changes, etc., much as we have it now and as it has been found to be in the ages of experience? I say probable permanence, for nearer than probability we cannot, from the nature of the subject, come to it; and it becomes us to be modest in our expressions concerning it,— this idea,

however, being implied, that whenever the phenomenon of the universe came first into existence, the Almighty produced it, and whenever it may go out of existence, it is He who will so affect it; that it is by Him that it exists, and without His presence and the exercise of His creative power it could not exist. This idea or hypothesis, if you so term it, is, you see, quite simple, and perfectly consistent with science and theology. Neither science nor theology can ever clash with this hypothesis, worded in this manner, for it modestly leaves the cosmical phenomena in *statu quo*, and gives sound reason for so doing, does not plague people out of their wits with high-sounding words and empty speculations as to the past and future of the cosmos, but grounds them in the faith of the existence and governance of that Supreme Being who doeth all things according to His good will. The beginning, therefore, may have been at any point of duration called the beginning of time, and we are easy as to it; and the end may become at any point of duration called the end of time; and by the course we take we endeavor to make people prepared for it. It is herein further considered that light, as any other cosmical phenomenon, is a creation, which, doubtless, has been as long as have been the attendant cosmical phenomena; which we experience to be manifested wherever the conditions necessary to its manifestation exist; and which for the future as for the past, in regard to the existence of the cosmos, we may contentedly leave in the care of the Omniscient and Almighty Creative Power.

I have shown elsewhere that matter and spirit, literally considered, are the same, it may be in different states as to density and rarity, or that really considered they are the same in the same state. This knowledge goes far to remove difficulties out of the way of a perfect understanding, so far as an understanding can be had, of the Creator and the cosmos, and to show the creation to be the effect of which God is the cause. People think they understand what matter is, although they cannot understand what spirit is, the truth being that they have only their ideas or impressions of matter, without having intimate knowledge of the substratum of those ideas or impressions; for if they understand not what spirit is, they understand not what matter is; but the knowledge of their ultimate identity must bridge the chasm which separates them in the common mind, and by so much, simplify the subject. Matter, as to its essence, is quite as inconceivable as is spirit; the smallest part of it can neither be created nor annihilated by man's power, and can it be understood essentially by him?

Now, as to the probability of the permanency of the cosmical phenomena, we can only suppose what will be from what is and what has been. It would be straining matters wonderfully, nor do I think it would honor the Creator in any way, for us to limit in our opinion the time of the existence of this cosmos to six thousand years, or less, as according to the Jewish computation. The Creator certainly does not require us to go out of our way to assert that He first produced this creative effect at some particular point of duration, called the beginning of time, when He might have produced it at an entirely different point called the beginning of time, and which if it were produced at any one particular point of duration rather than at any other, we allow that He has produced, and He only. A few moments' consideration will, however, convince any one that it is more difficult to conceive of a Creator without a beginning, as the Creator is, existing alone without a creation, and more contrary to reason, than to conceive of a Creator omnipresent, omniscient and omnipotent, always engaged in displaying His creative power, and in supporting and governing His creatures. "My Father," says Jesus, "worketh hitherto, and I work." The first complete sentence of the Bible says literally: "In the beginning Gods (the plural form Elohim being used), created the heaven and the earth," and the first complete sentence in Prof. A. B. Johnson's "Treatise on Language" says: "Man exists in a world of his own creation." But, whatever may be meant by these passages, it surely will do no honor to the Creator to forge untruths about Him under the pretence of exalting His character in the estimation of the people, when the truth will answer just as well and be more effectual for the honor of His name among men.

From my general observation of the phenomena of nature, and from my spiritual experience in and after my birth from above, I conclude the Creator does things in His own way, yes, absolutely as He wills; but generally, I find, He brings about results in a gradual, progressive manner, exemplified, if you please, by the regular order of nature and by reason. I judge, too, that injustice may easily be and is often done to the Scriptures by applying a literal interpretation, for example, to figurative language, and, perhaps, sometimes the converse of this, and thus necessitating them to convey a meaning different than that they were intended to convey. Comparing the New Testament with the Old, and the component parts of each with itself and with those of the other, so that the Bible may be its own interpreter, I think it will be found

that the Scriptures generally have a closer reference to the world of man than to the material world, and that the creation spoken of in Genesis has rather reference to a spiritual and moral elevation of man, somewhat as an antecorrespondent of the regeneration spoken of in the New Testament, than to a then primal production of the cosmical phenomena. It may have been 6,000 years or more since some remarkable change took place spiritually, morally and mentally in the then world of mankind, or in part of the same, corresponding to the creation spoken of in Genesis; but this could not refer to a primal creation of the cosmical phenomena which we experience, though still we know that in the beginning God created the heaven and the earth, which, but for the continual exercise of His creating and sustaining power, could not exist.

Now, as to the time during which these cosmical phenomena have existed it would be unnecessary and impertinent in us to begin to attempt an approximation, just as it would be to try to approximate to the time during which they shall continue to exist. As I have remarked before, we have proofs in geology of prodigiously long periods of time, and shall we be bold enough to assert that the cosmical phenomena began with those geologic changes? It may appear evident from the rotundity of the earth that those geologic changes which we observe to have taken place were but the successors of others, all traces of which have disappeared in the earth's interior and in the hard granite. The areas of the water and the dry land are continually changing place from age to age upon the earth's surface. The desert of Sahara, in Central Africa, has not very long ago been the bed of a sea, and so it has been in no very distant age with great part of the interior of America. Islands and large areas of land sometimes go beneath the waves with all on board, and other spaces are set free from the waves or are produced by the indefatigable labors of the coral insect. The marks of the glaciers of a bygone age in our latitudes and south of us present to my mind no slight indication that the polar regions do betimes throw off their coats of snow and ice and go to work to producing, while the temperate zones and equatorial regions go under their snowy blanket to sleep. These changes, doubtless, take place so gradually as to enable the species, almost insensibly, to seek more congenial latitudes. The cause of those climatic changes will, perhaps, ultimately be found in that movement of our sphere called the precession of the equinoxes, which would give its seasons of activity and rest alternately to each of those regions respectively in a little less than 26,000 years.

As to the Species Man.

I shall now glance at things which pertain to our own species. Man is the most important member of terrestrial existences, at least so he himself thinks; and, although much exalted in power and dignity over all the other creatures, he yet is subject to the accidents, if we may term them accidents, of nature. The previous part of this discourse has, at least, implied that man has an immortal soul or spirit; but is he acquainted with the nature of that soul or spirit? Does he know anything more about that soul, the real self which he is, than the ideas or impressions imply which are conveyed to him through the senses. It is true that a very acute writer has said that "a substance which cannot be discovered by our senses is as insignificant as an elephant that cannot be discovered by our senses." But notwithstanding this assertion, the substratum of our ideas, the real being, is inconceivable, as being infinite and illimitable. Ogilvie, in his "Essays on Human Knowledge," says: "Of the substance and essence of either mind or matter we know nothing and can know nothing." A proper discrimination and exercise of the senses do, however, assist to the acquisition of a great degree of accurate knowledge, so far as knowledge is attainable.

Man has existed on this earth for, who can say, how long? In fact the question of the time of the existence of man upon the earth is as the question of the existence of the earth itself, or of the cosmical phenomena; it is a question. We have perfect liberty to investigate that subject, and speculate as to it, and draw our inferences or conclusions from the data we find concerning it, as we have in the case of any other subject of investigation. In doing so we cannot offend either God or man, but may increase our knowledge. In our geologic researches we do not find the remains of man strewed so broadcast as are the remains of the lower species of animals. The general cause of this is reasonably supposed to be that in all the ages of which we have knowledge of man he has been accustomed to dispose of his dead by burial, by burning, etc., and we presume he has acted thus in the preceding ages of which we have no knowledge of him. Many of the human remains discovered broadcast have been found in alluvial deposits, indicating them to be the remains of people who had been drowned in rivers, the bodies being washed down with the debris. Many remains

have been found in deep caverns, and in other situations where it was evident they had lain for long ages. Others preceding these have disappeared in the processes of change, and have, doubtless, gone through manifold transformations of existence since being in the human form. We recognize the remains of the human being in the skeleton we find, but rarely think in connection with this of tracing further in our mind the endless changes and transformations of matter in regard to the dissolved houses of the generations of generations which have trodden the earth in the ages of ages preceding. All things change; but that vital principal which lives and animates and thinks and rationalizes, which is incomprehensible, that vital principal, I say, the real self, never dies; that is, it always lives, is always vivifying principal.

From the exploration which has been made of the earth's surface by sea and land, I think there is no reason to doubt but that most of the human races which exist on the earth have been discovered. There is but one species man, for though it is found, by the examination of mummies, that the incisor teeth of the ancient Egyptians, which, in the human races generally have sharp, cutting edges, were truncated, it is reasonably concluded that this result was achieved in them by filing the teeth, inasmuch as some other African races are accustomed to use the file upon their teeth, but to produce a different result, namely, to sharpen them. The cuspidati in those people had also the appearance of truncated cones. The teeth of some Coptic children, however, who had died under five years of age, having been examined, were found to be precisely as the teeth of the children in other races, which was taken to prove that the abnormal dental condition in the adults was due to artificial means. Capt. Fitzroy stated that the teeth of the New Zealanders and Fijians were at first sight like those of a horse; that they are all worn down, canines, incisors and grinders, to a uniform height, or that they are of a peculiar structure. He observed similar peculiarities in the teeth of the Patagonians and Fuegians of South America. But a really natural or unnatural and abnormal physical variation in the case of the Copts was, and is, that they have the ears set very high on the side of the head, being an inch and a half or two inches higher than in ordinary men, so as to present the appearance of little horns. The instances I have adduced, are, however, reasonably concluded to be only well-marked variations from the ordinary human type. On the whole, then, men in all parts of the world form only one species, this, however, con-

taining many varieties. Climates and conditions of soil, character of food, etc., do, I think, in the course of ages, produce most or all of the varieties we have in men. We have men varied in physical appearance and structure, in character and texture and color of the hair and skin, in language, etc. As to such variations we have analogies in each of the lower species of animals, and even in the species of plants, so that it is no wonder if man has varied in these respects. In the species sheep, for example, we have some varieties covered with hair and some formed differently as to the legs and body than the ordinary type; some varieties have horns, some are of black color, etc. On the other hand, some varieties of Asiatic goats are covered with wool, and any one can see the many varieties there are among all the species of domestic animals. Is it any wonder, then, that the species man should present varieties in like manner; some of its varieties having hair like wool, and others having straight hair; some having it crisped, and some in dry, woolly tufts, scattered here and there over the head, like as tufts of dry grass scattered at intervals over an arid plain. Some races, as the Ainos, of the Kurilian Islands and the lower Amoor, having their bodies covered all over with long black hair, some having a white skin, some black, and some being of all hues of color between these two extremes; some having long limbs and a short body, and others remarkably the contrary of this; some having a projecting forehead, and others a receding one; some having the head of a pyramidal shape, others of a round form, and still others of an oblong shape; some having the cheek bones high and projecting, and others having them low; some having the pelvis nearly of a circular shape, while in others it is oval. Such and numberless other variations are to be met with in the species man, so that frequently even two brothers or two sisters are found to vary remarkably from each other. There is no doubt, as I have said, that external conditions, as circumstances of soil, climate, etc., go far to producing the general varieties in the animal and vegetable species, and in man, which we meet with in the different latitudes and zones of the earth. But it appears that each species, though presenting many varieties within itself, has stamped upon it its own particular nature and character, by which it is distinguished from all other species. So it is pre-eminently with man, who has the erect form, the modest, intelligent and commanding look, made in the image of God and endowed with reason to have dominion over all the other species. Now, it is well known, that cross-breeds

between different species of animals die out after one or two generations, but all the varieties of the species man procreate with each other in the most fertile and permanent manner, which is a proof that there is but one species man, however well marked the varieties within it. I do not see, therefore, where comes in the expression *genus homo*. The Bushmen, a branch of the Hottentot race, were at one time thought too low in the moral scale to be classed among mankind; but due reflection and experience of them has rectified that idea, and although degraded indeed morally, and low physically, they are still allowed their place among human kind.

Now, since men of all countries and climes are of one species, should they not have a mutual interest in each other's welfare and happiness. Instead of biting and devouring and limiting one another on account of selfestimated superiority or inferiority, subjectively or objectively, arising from alleged place of birth and the like, they should rather love each other and seek each other's good. While not of those who deny that a timely word of rebuke and correction, when needed on account of public malfeasance, should be spoken by those sober and just men who are fittest, and whose voice will be heard farthest, I have no idea that place of birth does of itself render a man either superior or inferior to his fellows. This being certain, it is plain that this infernal jargon as to nationality, in which so much precious time is lost in questioning and jibing, in favoring and hating, etc., on account of that nothing, should be dispensed with as in general unnecessary, unmannerly, and impertinent. In this country, at least, where every American citizen cannot be supposed other than an American, a question as to one's nationality, like as a question as to one's religious tenets, must, generally speaking, be impertinent, and the questioner should not feel offended if he be not always favored with an answer, so that his mind may be left unencumbered to attend to his proper business. When a nation or community is prosperous its people are likely to be proud, and, on every occasion which may offer, to insultingly insinuate or ring out their nationality in the face of those whose country may not be, in that age, so well favored. Such men proclaim aloud their nationality, and pretend to know that of other people at first sight, making their mind known by inuendo or question. They should learn to wear on their person that inestimable jewel called good manners, and to cultivate in their hearts unfeigned love for all their brethren of mankind.

During the last two thousand years there has been a great comingling with each other of the Noachian races. Of these races some displayed remarkable energy and enterprise, migrating from their original homes and conquering and settling territories when the circumstances of their situation required or other incentive moved them. Now, considering those mutations for such long ages you will conclude, at least with respect to the individuals of those races, with their languages, which have dominated for the last fifteen centuries, that it is quite impossible that most of them should know whence, in the male line, they are descended. The most intense English nationalist of to-day, for example, may be descended from the ancient Irish, and the most intense Irish nationalist from the ancient British or German. Proper names count for little as indicators of descent, they being, some of them, of arbitrary application, and largely derived from occupation, station or accident. It may be unnecessary for me to say here that the Gothic or Cuthite races, whether under their derivative name Gaulic (Gædhalic, *i. e.* Gothalic) races and languages have, in the time specified, dominated generally in the northern and southern regions. There is, too, a mixture of Mongolian in those Gothic races even to the western boundary of Europe; and, speaking independently of our descent from the people of that quarter, it may appear that America should not invidiously distinguish and shut its doors against the people of China or any other particular race of men, brethren of the same cosmical dwelling as they are! Whether or not men differ as to place of birth or as to language they should none the less love each other and will and do each other good.

It must be allowed that we live in a more enlightened age than any that has preceded us, of which we have knowledge. Theological and scientific dogmatism is now rarely manifested, for, in consequence of the general intelligence of the masses, the language of the learned has become more full, and every theological and scientific dictum is likely to be hedged round with numerous limitations and qualifications. Some modern authors have done good work in the way of abridging. It would be an insipid task for one of our practical republican scholars to have to search through a thousand musty and turgid tomes of European and Asi-

atic lore in order to find the ideas which, for his purpose, he may find better expressed in one or two.

But the investigation and study of the antiquities pertaining to the ancient races, which preceded each other on the continents before the coming on of the actual races, have about equally divided the interest between the ancient eastern and western hemispheres, the vestiges of mankind in the latter appearing even more ancient than in the former, and having a general aspect peculiarly American.

Human Languages: Their Origin, etc.

If we consider the languages of the ancient American races and those spoken by the ancient aborigines, after the arrival of the Europeans in the fifteenth century, of which the whole number was reckoned at from fifteen hundred to two thousand, we shall find that they differed almost entirely from each other, even those which might be supposed the nearest of kin, in the words or sounds they made use of to express the same ideas, as, for example, the names of the most familiar objects, such as father, mother, brother, sister, day, night, sun, moon and the like, it being claimed that there were as many as a hundred groups of languages on the continent between whose words were discovered no correspondences which might not be sufficiently explained as the result of accident; and still there was a similarity of grammatical construction among all the languages of the continent, south and north. This last is generally taken by philologers as a mark of the relationship of languages, but I see not how it can be any sure mark of the kindred origin of the people using the languages, more especially if their vocabularies are remarkably or totally different from each other, as we know that some of the ancient people of Europe and Asia borrowed their alphabetic characters and grammatical construction from others who were of totally different stock. The American languages, generally (that is, with the exception of the dialect of the Otomi in Central Mexico, and perhaps some others, which are said to be monosyllabic), are formed on what is called the polysynthetic or incorporative type, that is, they incorporate into their verbal forms not only the subjective and objective pronouns, but also a great variety of modifiers of the verbal action, adverbs in the form of particles and fragments of words. Thus, almost everything which helps to express ideas, forms a part of verbal conjugation, and the verbal paradigm consequently becomes well-nigh inter-

minable. They have the peculiarity, also, of combining words by fragments, that is, by one or two representative syllables selected from each to form a word. This polysynthetic principle of construction tends to the excessive and abnormal agglomeration of distinct, significant elements in words, whereby both unwieldy compounds are formed as the names of common things, and a character of tedious polysyllabism is given to the language, as is evidenced in the three to ten-syllabled numerals and pronominal words of the western Indian tongues.

The American aborigines generally practised picture-writing in its rudest and simplest form for the intercommunication or recording of ideas. The Mexicans, at the time of the conquest, were found to have attained to great perfection in it, as indicated in their intricate and skilfully constructed calendar, in which the periods of greater or less length all derive their appellations from natural objects, and were indicated in writing by the figures of these objects. The Mexican annals were full of names and dates composed of figures designating the spoken signs of things. As to what the real character and condition of Mexican picture-writing was at the time of the conquest authorities differ, some holding that it had already become a representation of continuous spoken texts. That there was quite an extensive Mexican literature is certain, but the ignorance and fanaticism of the Spaniards swept it out of existence.

The ancient Peruvians used quippos, or bunches of knotted cords, as practical means of communication and record. With these the State accounts and annals of the Empire are claimed to have been intelligibly kept. With them the State messengers were provided, and by their numbers, their colors, their groupings, and their style of knotting, they were conventionally significant of each one's message, even to partial independence of his own oral explanation. Doubtless the Peruvians made out of this coarse instrumentality all that it was capable of becoming, but their essentially low grade of civilization is shown by the fact that they had risen to nothing better. Curiously enough, the Chinese have preserved the tradition that their ancestors kept their records by means of knotted cords until the mythical emperor, Fohi, devised the superior method of pictorial monography.

The genuine African languages, among which the ancient Egyptian or Coptic is included, have a great disparity in the words expressing the same ideas, but from their grammatical construction presenting great similarity throughout, they are artificially placed

as one class of languages distinctively African and presenting marks of great antiquity.

The languages of Europe and Asia may be divided into three groups, namely, the Syro-Arabian, the Arian or Indo-European, and the Allophyllian or all the languages not of the stock of the two former. The Syrian, Assyrian, the Arabic and the Hebrew, with the kindred dialects of each are the branches of the Syro-Arabian. The term Shemitic was first applied by Eichorn to this class of languages, and was adopted by later German and English scholars, but Gesenius has objected to its use that some of the nations who spoke dialects of the common language were, according to Bible genealogy, descended from Ham, which will be understood by reference to Genesis x: 6-21. A remarkable fundamental difference between the Indo-European and the Syro-Arabian languages is that in the former class the original roots of words are almost universally monosyllabic, while in the latter they are so universally dissyllabic or triconsonantal that it has been generally considered as belonging essentially to the groundwork of the languages of this class, placing them in a different category from all other human idioms. Indeed, it is said that while the origination of some of the languages of the Indo-European stock may be due to spontaneity and the occasional development of a few original elements, the artifice of construction is so deeply inlaid in the original elements of the Syro-Arabian languages and the principle of expression so refined and metaphysical as to bear the appearance from the start of a premeditated plan. This Syro-Arabian class of languages, which are all written and read from right to left, and in which the roots of words always consist of three consonants, includes on the one hand the Syrian or Aramaean and Chaldean, then the Arabian in all its dialects, and lastly the Hebrew or Phœnician. As the Phœnicians, Canaanites and Hebrews spoke one and the same language (the Bible giving a different line of descent from Noah to the Hebrews and Canaanites, namely, from Shem and Ham respectively, and another genealogy, that of the Gaels of Ireland and Scotland making the Phœnicians descend from Japhet), it is surmised that some one or two of these peoples must have adopted the language of the other. That the Hebrew is identical with the language of the Phœnicians or Canaanites — that is, with the language spoken by the ancient inhabitants of Palestine and with the Punic of Africa — has been proved by Gesenius in his works on the “Phœnician Inscriptions” and on the “Hebrew Language.”

He maintains that the Hebrew, Phœnician, Canaanitish and Punic were in fact one language; that they had a common vocabulary and the same laws of grammatical construction, and differed in the same particulars from other Syro-Arabian dialects. Herodotus, who was well acquainted with the Phœnician nation, is supposed to have meant by the people whom he styled "Syrians of Palestine," who dwelt at the city Cadytis (supposed to be Kadesh, the Holy City, or Jerusalem), the Jews. Now, these latter might well be supposed to have adopted the Phœnician or Canaanitish language if they had grown up within the country from such small beginnings as one patriarch and his twelve sons. But in Acts vii: 6, it is said or implied that the Israelites, after the death of Jacob, dwelt in Egypt four hundred years, by which time they could have spoken only a mixed dialect of the language they brought with them, and in verse 36 it is said that they wandered in the wilderness forty years on their way to Canaan. Now, in Numbers xxvi: 51, the sum of the Israelitish warriors over twenty years of age about to invade Canaan is given at 601,730, so that the whole number to enter Canaan under Joshua could not have been less than two and a half or three millions; and, now, seems it wonderful, that this conquering nation, supposing their language to have been considerably different from that of Canaan, did not impose their language with their dominion and laws upon the conquered, and did not make any traceable impression upon the vocabulary of the existing language? But further, in Acts xiii: 20, Paul makes the period of the Judges, after the entrance to Canaan and before there was any king in Israel — an obscure period, indeed, — to have been four hundred and fifty years. This, or nearer five hundred years, brings the period down to the time of King Saul, and it is not very likely that the records of the Bible preceding the books of the Kings were compiled before the time of Saul or some of his successors. I am not aware that the Jewish nation is brought distinctly to our view by any outsider before the invasion of the East by Alexander, and afterward by the Romans. About four centuries before Christ the Hebrew ceased to exist as a vernacular tongue, and was replaced by the Aramaic, the dialect of Syria.

Gesenius considers the only difference which could have existed between the Phœnician and the Punic was merely a variety of pronunciation. He declares the idiom of Numidia, in Northern Africa, to have been pure Hebrew. Indeed, there exist in various parts of Africa dialects of the Syro-Arabian language, now called Hebreo-

African, and which are, therefore, different from the class of genuine African languages. Of these, the Ethiopic, the Geez and Amharic of Abyssinia, the Galla, the Lybian or Berber, the Tuaryk, and the Shuluh are widely spoken and well-known idioms. Everything considered, the class of Syro-Arabian languages appears to be peculiarly Noachian.

The ancient Egyptian, with its successor, the modern Coptic, was a language of the utmost simplicity and of poverty of grammatical structure. Its roots, which are also its words, are generally monosyllabic. Its words have no characteristic forms to distinguish them as nouns or verbs or other parts of speech; nor can a word be traced back to a simple radical element from which it is derived by the addition of a formative element. Some roots, as in Chinese, are either verb, noun or adjective, others are only verbs or only nouns. The personal inflection of the verb is effected by means of suffixed pronominal endings, loosely attached and capable of being omitted in the third person when a noun is expressed as subject of the verb. A word used as a substantive is generally marked by a prefixed article which is not closely enough combined with it to become part of it. It has no declension, the objective uses being indicated by prepositions. Mode and tense are, to a limited extent, indicated by prefixed auxiliary words. In the singular number of both articles and pronominal suffixes as also in the pronouns there is a distinction of gender made, as masculine and feminine. This fact, taken together with some striking analogies which the Egyptian pronouns present to the Semitic, is thought by some philologists to indicate kinship between the Egyptian and Syro-Arabian languages. But the general character of the Egyptian language forbids its being so classed, it being rather but a single step above the Chinese; in many of its constructions quite as bald as the latter, and often less clear and free from ambiguity. It, doubtless, belongs to an African people which inhabited that country antecedent to the time of the rise of the Syro-Arabian nations. The class of genuine African languages is distinguished from the Allophyllian languages of Asia by the use, to a very considerable extent, of prefixes to the root.

Over a great part of Asia and most of Europe the Aryan or Indo-European, a class of languages distinct from the Syro-Arabian, now prevail. The Indo-European nations have been divided by the affinities of their languages into two principal classes, generally termed the Indian and the Median, or

those of the southern and of the northern stems. The former class have languages of which either the forms have been better preserved, or they were originally more elaborate and more refined in grammatical structure than the idioms of the latter. Among the most obvious traits of distinction between them is the peculiarity that in the interchange of consonants discoverable when the words of one idiom are compared with those of another, the Median and all its branches frequently substitute hard gutturals for the soft and silibant letters of the Indian. To the Median or Northern branch belong more especially all the Persian and Germanic dialects; to the Southern belong the Sanskrit and the classical languages of Greece and Italy. The other European languages belonging to this great family have much that is common with the Median or Germanic branch, yet they cannot be set down as strictly belonging to this division. Of the two Celtic divisions the Irish (which is found by some philologists to indicate in its vocabulary a close affinity to the Phœnician), including the Manx and the Scotch Gælic, has much that is common to the Median, but belongs more generally to the Indian or Southern branch. The Welsh, including the Cornish and Armorican, while having much that is common to the Southern, belongs more generally to the Median or Northern branch. All the branches of the Indo-European languages display such marks of relationship, especially in their grammatical structure, by inflection, conjugation, etc., and more or less in their vocabularies also, as to suggest that they pertain more or less remotely to one original stock.

All the nations of Europe and Asia which are alien to the Syro-Arabian and Indo-European branches, are, as I have said, and as the term indicates, called Allophyllian races. These are, first, the ancient Iberians of western Europe, whose language, called the Euskarian, is exceedingly peculiar, intricate and difficult of analysis. It is thought to possess more striking analogies with the aboriginal languages of America than with any others that are known. Like them, it is highly polysynthetic, incorporating into its verbal forms a host of pronominal relations, which are elsewhere expressed by independent words. Like them, also, it compounds words together by means of representative fragments; but it does not show the same tendency to fuse the whole sentence into a verb. Its nouns have an inflection which is much more Asiatic than American in type, and there are other differences which distinctly discourage the conjecture that it can be historically akin to the

American languages. The Iberians are supposed to have inhabited Italy, Spain and Gaul. Separated from them by the Celtic and Germanic races are the Jotunes or Ugorian race, belonging to the north of Europe and Asia, and stretching from the Danish isles to the river Obi. This group includes the Finns and Lapps, the Tschudes, the Vogules of the Uralian mountains, the Ostiaks of Siberia, and the Magyars or Hungarians. Beyond the Jotunes, toward the north and east, are the Khasova, a race termed by the Russians Samoyedes. These are spread along the northern coast of Europe and Asia, from the White sea to the mouth of the Lena. Other tribes of the same race are found on the confines of the Russian and Chinese empires, in the high regions of central Asia. Beyond the Samoyedes several fishing and hunting tribes occupy the country reaching from the Lena to Behring's strait and the Pacific ocean; but, as they speak several distinct languages, they are accounted different races under the collective name Paralian. The high regions of central Asia are divided between three great pastoral races, the Turkish, Mongolian and Tungusian. One of those races has overthrown the Khalifat and the Eastern Empire; the second, under Zhinghis Khan and his immediate successors, were the greatest conquerors known in the history of mankind; and the third now holds under its sway China and the half of eastern Asia. There are thought to be some slight grounds for believing these three races to have sprung from one stock, and that the Jotunes are allied to them by an ancient affinity. The Thibetans and Chinese, together with the Japanese and Koreans, form another remarkable group of nations. Although not referable to one race, they bear a mutual resemblance to each other. The natives of the Dekhan, or peninsula of India, and those of Ceylon, differ from the Hindoos of Indo-European origin both in language and physical character. The Indo-Chinese, or native tribes of India beyond the Ganges, including the Cochin-Chinese, the Annamese, Siamese, Burmese, etc., as the Chinese proper, speak languages termed monosyllabic. The inhabitants of the Malayan peninsula are reckoned as another family of Asiatic nations, both in physical character and language. Also, the native races of Georgia and the Caucasus consist of several apparently distinct tribes, speaking different languages, which in their vocabularies show an affinity with the languages of northern Asia, including the Finnish, that of the Samoyedes and Tschudes.

Now, as to the languages spoken by the Allophyllian races of

Asia and Europe, the following are the most remarkable of their common characters : 1st. Nouns have no variation of gender, or, for the most part, of number. Nouns are in fact destitute of all inflection and can only express a plural on particular occasions by appending a noun or adverb of multitude. 2nd. They admit of no prepositions before nouns, but those particles which are used instead of the prepositions of other languages, and likewise all such auxiliaries to composition as are necessary for denoting any circumstance or affection of the principal words of a sentence are suffixed (without being incorporated) or placed after the words of which they modify the meaning. This observation extends to words answering the place of possessive and relative pronouns ; and to verbs, for verbs are nouns denoting a state of action or passion as to the subject which they represent, and which are indicated in the inflected languages by prefixed and affixed incorporated formative elements. 3rd. Derivation by prefixes is unknown ; the radical syllable always stands at the beginning of the word, followed by the formative elements. The root, to whatever extent it may receive the accretion of suffixes, remains itself unchanged, being neither fused with them nor euphonically affected by them. But while the root receives no modification from the endings, the latter are modified by the root in a strikingly peculiar manner. The vowels, namely, are divided into two classes : heavy (a, o, u, etc.) and light (e, i, ü, etc.) or guttural and palatal ; and, in the suffixes, only vowels of the same class with that of the root or with that of the last syllable of the root, if there be more than one, are allowed to occur. Hence every suffix has two forms — one with light vowel and one with heavy, — either of which is used as circumstances require.

It has been remarked that the Chinese and Sanskrit languages exemplify two of the most opposite methods of construction. The Sanskrit denotes all the relations of words and of ideas by grammatical forms, written and expressed in pronunciation. The Chinese, being a language of symbols, leaves the perception of these relations to be the work of the mind. Paradoxical as the observation may appear, it is found that the Chinese language, by the apparent absence of all grammatical forms, tends to enforce acuteness of the mind. To people who spoke such a language it was natural to invent writing by means of pictures or symbols of ideas. The ear perceived words as monosyllables, and the mind invented monograms to represent them to the eye ; and the habit of

thus representing words by particular and unconnected visible forms contributed secondarily in a great measure to the preservation of distinctness in monosyllabic words. Much greater exercise of the understanding is, however, required in carrying on a conversation in the Chinese than in the Sanscrit, where all the relations are at once understood by the sound expressed. The vocabulary in the cultivated dialect of the Chinese consists of only about 450 vocables or different combinations of sounds, but these are converted into about three times that number of distinct words by means of the tones of utterance. Not only the grammatical form, but also the radical significance is often left to be understood by the connection, and here the Chinese finds a near parallel among inflected tongues in the numerous homonyms (words identical in sound but different in meaning) we have in English, as, for example, in our word sound, a noise, sound, an arm of the sea, sound, in safe and sound, and sound, to try depth by a depending line and plummet. The language being full of homonyms, a sign being found for a word in one of its many senses, the device was naturally suggested of making the same sign answer for some of its other meanings also by the aid of an appended diacritic sign; whence comes the strange anomaly that a language composed of but one or two thousand words is written with an alphabet containing 40,000 different signs, of which all that are commonly used are but from three to eight thousand. Some signs are very extensively used to form phonetic characters in connection with others which bear a phonetic value in the compound; for instance, the sign for man enters into nearly 600 combinations, all denoting something having a special relation to man; that for tree enters into more than 900, which denote kinds of tree, wood, things made of wood and the like. Their analogy with the formative elements of spoken language is evident; they are signs which limit the general value of the phonetic radical, putting it in a certain class or category of meanings,

By far the most important of the monosyllabic group of languages is the Chinese. Its literary records, as, for example, the Shi-King, claim to go back to nearly two thousand years B. C., and the annals and traditions of the race reach many centuries farther, so that the Chinese literary antiquity almost exceeds both Syro-Arabian and Indo-European. While its uttered vocabulary is one of the poorest in the world, its written one is eminently rich and abundant. Its systems of signs combines a phonetic and ideo-

graphic character in a manner peculiarly its own. The Chinese culture, on the whole, has spread as much light and caused as much happiness as any of which we have historical knowledge. The prevailing language of China in the present age is the Tungusian, or that of the ruling dynasty which introduced itself from high Asia, but there are said to be as many idioms spoken in the empire of China as there are languages included in the Indo-European class, and some of them differing as much from each other as the languages of the latter class differ among themselves. Repeatedly subjected to foreign domination China has always, eventually, vanquished her conquerors, compelling them implicitly to adopt her civilization.

The language of the Japanese differs from all the languages we have mentioned, being entirely different both in its vocabulary and structure from the Chinese, from which it has borrowed only words connected with the progress of art and civilization. It is a polysyllabic language, and, as to its structure, appears to occupy somewhat of a middle place between the general idea of the Indo-European and Allophyllian languages, though approaching nearer to the latter class. The languages of the Kamtschatkans and those of the Kurillian Islanders and the inhabitants of the lower Amoor, are peculiar to themselves, having little in common with others. The Tschuktschi, the Koriaks, and the Namollos, who inhabit the Asiatic peninsula terminating at Behring's Strait, speak languages more or less akin to those of the tribes on the American side. In fact, both physically and philologically considered, the tribes on both sides of this strait are found to be closely akin. Of the Ostiacks and Vogules of Siberia many of the words bear in their form and construction a striking resemblance to those of the Koluschi and Aztecs of the northwestern and central regions of America, which is particularly noticeable in the peculiar termination *tl*. All the aborigines of northern Asia and Europe appear to be more or less remotely related to the northern American tribes. In the prominent features, pyramidal head and general physique, the American aborigines and the northern Asiatic races bear more or less of a resemblance to each other.

Philologists have found it very difficult to explain the phenomena presented by the American languages, that is, the great analogy of grammatical structure coupled with the immense diversity of words. It has been wondered whether the American races possessed any organic peculiarity which led them to construct an-

guages of similar formation in all parts of the continent, and the tone of some very eminent investigators, who have done so much in bringing to light the American antiquities in the different parts of the continent, would lead one to suppose that, in their belief, the ancient Americans did possess some such organic peculiarity. The American languages constitute certainly as distinct a class of languages as any other in the world. Considered in relation to other classes of human speech, they are unique. The Chinese and the American languages, as far as relates to their organizations, stand in direct contrast to each other; they form the top and the bottom of the scale of human idioms. The Chinese is of all languages the poorest in words, as well as in grammatical forms, while the American languages are the richest in both. A great variety of grammatical forms necessarily imply a great multiplicity of words, especially when spoken of the complex grammatical forms, and the compound polysynthetic words of the Americans.

Human language in its simplest form appears to arise spontaneously and necessarily from the mind or reason and imagination of human beings in their relations to each other, and in its complex, grammatical structure to be the gradual product of their invention. This leaves the peoples in the different and widely-separated regions of our sphere to produce their languages, of whatever character each language may happen to be, when developed, absolutely independent of each other as nations (but we know from history that nations sometimes derive assistance from other nations in the matter of grammatical structure), and the knowledge of it may remove an obstacle out of the way of the proper locating of "the cradle of the human race." Language, as a system of sounds or symbols representing things or ideas of things, derives its value from the mutual understanding of human beings with each other; for language, properly speaking, requires for its development a plurality of human beings, and takes time to produce it. There are some so foolish as to believe that God created by a few *fiats* the world and man and languages all in a few days. God with them is no God if He do not show them a sign; if He do not produce such great effects as the creation of worlds and men and languages according to their notion rather than according to His own eternal law. Upon such men all the influence of historical science is thrown away; they are capable of believing that a tree, which they have not themselves seen spring up from the seed, was created whole in the state in which they find it, without

gradual growth. But to suppose that it has pleased God to work thus is to make the most violent and arbitrary assumption, one which imputes to him a capricious readiness to trifle with and deceive the reason with which He has endowed His creatures. Now, to suppose that language was first produced by a miracle and then left to conserve itself is a childish philosophy. We may compare it with the wisdom of the little girl, who being asked who made her replied: "God made me a little baby so high" (dropping her hand to within a foot of the floor) "and I grew the rest." The power which originates is not to be separated from that which maintains and developes. They are one in essential nature and general mode of action, though the mode of action, as the nature, be mysterious and not understood by us. As well claim that the simple digits must have been miraculously revealed for elements out of which men should proceed to develop systems of mathematical notation as that the primitive signs of spoken thoughts must have had such an origin. Speech, however rude, is the offspring of reason, and may be called reasoning, just as the Greek word *λόγος* means both reason and speech. The origin of language is divine in the same sense in which man's nature, with all its moral and physical capacities is a divine creation; it is human in that it is brought about through that nature by human instrumentality.

From the glance we have taken at the races and their languages, it may appear that the Indo-European language is not so prevalent on the globe as its great name among us might imply, the Chinese language being spoken by a greater number of people. Even in the heart of India and in the centre of Western Asia, where we might least expect it, we find Allophyllian languages spoken. Without knowing better we would be likely to class the Georgians and the Caucasians as Indo-Europeans, but we find them and their languages to be of the other stock, and the Armenian to occupy a doubtful position, but approximating more closely in construction to the Indo-European. If we only consider the character and construction of the Greek and Latin languages with which many of you, doubtless, as myself are familiar, and whose literature and thought expressed by their own writers are dear to us all, I doubt not those of you who have studied and compared closely their grammars, have concluded that they are considerably different from each other in their construction — the difference in their vocabularies is easily observed — you will, I say, conclude with me they could not have been other than the

product of a long age. In many respects every language of the Indo-European stock forms by itself an organic whole, with its own historical development, independent of the sister tongues. Thus, the Latin language, without defacing or destroying those features by which we recognize it as a member of a great class, has passed through a peculiar course of organic development, until it became the mother tongue of the languages of Southwestern Europe, all of which again preserve the characteristic features of their common origin. It is found that the Latin language is not derived from the Greek, nor the Greek and Latin from the Pelasgian, as some have supposed; but that they are sister languages, each in itself, as original as the Sanskrit, and each properly representing in its own structure and literature the character of the people by whom it was spoken?

The Romance and even the Romaic languages are, however, a fair illustration that in speaking of the origin of a language we often speak rather of the origin of the construction of that language, and perhaps of part of its vocabulary, than of the origins of the peoples who speak it. For who, for example, is so foolish as to think for a moment that all the peoples of France, Spain, Portugal, and Italy are derived from the Latins, or that the largest part of their vocabularies can be derived from the Latin tongue.

The ancient Semetic alphabet, of which the Phœnician is the generally accepted type, being, whether the original or not, the oldest traceable form, was a system of twenty-two signs, all of them consonants; three of them, however, namely, the signs for the semi-vowels *y* and *w* and the character we represent as *H*, partaking somewhat of a vowel character, and being, under certain circumstances, convertible into representatives of the vowels *i*, *u*, *a*. In its view only the consonant has a right to be written or to be written in full; the accompanying vowel, if noted at all, must be indicated by some less conspicuous sign attached to the consonant. This alphabet, not really supposed to be an original invention of the Phœnicians, but borrowed from some one of those nations of earlier civilization, by whom the Semites were surrounded before they entered upon their historic career, was the parent of the methods of writing used by the great majority of enlightened nations since the beginning of recorded history. From it came directly or indirectly the three Syro-Arabian alphabets, the Hebrew, the Syriac, and the Arabic, the two last of which have gained currency over a considerable portion of the world, as has the Hebrew, in its way, in the Old Testament Scriptures. These languages, in all their progress and

metamorphoses, have held fast to their primitive character of a consonantal alphabet. But in its progress towards Europe the Phœnician alphabet first fell into the hands of the Greeks, from whom it received its final perfection by the provision of signs enabling it to represent the vowels no less distinctively than the consonants. From the Greek alphabet have been derived, by modifications and adaptations of greater or less degree, several others, as the Coptic, or modern Egyptian, and the Armenian. The runes of some of the Germanic tribes and the early Celtic modes of writing trace their origin back to it, mainly through the Latin, as does the Russian, the most unsystematical of all its descendants. The Latin alphabet was taken from one of the older Greek dialectic forms, a form from which the Greek alphabet, with which we are familiar, also itself resulted.

From what I have said as to the character and construction of languages, without mentioning the races and their languages which exist in the Austral islands, and of those languages I have mentioned, some so ancient and perfect in construction having superseded others which had already grown old in use, it is evident that great antiquity is implied for the peoples who spoke them, and that the same inward, conscious nature and the same mental faculties are common to all the races of men.

If we now refer to the 27th, 38th and 39th chapters of Ezekiel, and compare them with chapter 10th of Genesis and with ancient scriptural geography, we shall be likely to conclude that the Syro-Arabian races and their languages were understood to include, at least largely, the races and languages of the sons of Noah, as we find most of the races descended from that ante-and-postdiluvial patriarch enumerated as accustomed to attend at the fairs of Tyre. We, then, might give to the account of the flood, of the preservation of Noah and his family, of the tower in the plain of Shinar, of the confusion of tongues, and of the miraculously long lives of the patriarchs from Adam to Noah and from Noah to Abraham, such an interpretation, figurative or literal, as in the light of history, language and experience they will consistently bear. We may, then, picture to ourselves Abraham, the son of Terah, going out from among his kindred, in obedience to the will of God, into a strange country, and may profit, if we will, by his distinguished example of obedience and faith. The recorded lives of the patriarchs, Abraham, Isaac and Jacob, are seen to have been remarkably according to nature, and appear to be designed for our example, to teach us

that we should be patient in all circumstances, trusting implicitly in God's goodness and guidance, and never becoming weary in well-doing; to teach us, in short, lessons of God's many-sided wisdom in His dealings with man.

Among the American races a tradition of a deluge was, I believe, very general, and the mountain nearest to or in the territory of each tribe was most likely to be that one on which the remnant of their ancestors had escaped. So the Georgians, a race whose language has been compared to the idioms of the North American Indians, claimed their descent from Japhet, that is, after christianity had been spread among them, they and the Armenians were privileged to trace their genealogy back to the same patriarch.

I have had occasion to remark with respect to the Scriptures that literal language should be interpreted literally, and figurative language figuratively, in order that the records be not made to contradict themselves, or that they may not be made inconsistent with themselves. Bishop Butler, in his Analogy, as well as Mr. Locke, places reason above revelation, the judge of it as of all other things. Bishop Colenso, on the other hand, gives, as a general rule of life, obedience to the inward monitor. While I would not be guilty of giving a contracted snarl at Bishop Colenso or any other man, whom I should judge to err slightly, I would simply say, in regard to the Scriptures, let right reason rule in their interpretation, and if the literal language obtain the proper literal interpretation, and the figurative language the proper figurative interpretation, they will be found not to contradict themselves. Now, if the New Testament any more than the Old is not capable of receiving *verbatim* and throughout a literal interpretation, this is no proof against its divine authority, when correctly interpreted, for taken altogether it will be found consistent with itself if the proper interpretation be given, and will generally be found to have a forcible and real meaning designed for application to real human life. It will be found largely, as to it, that the letter killeth but the spirit giveth life, that the letter is as the husk which covers the kernel within, as the cloud which betimes obscures the sun's face.

It may obviate misconception, if, in connection with the foregoing, I anticipate a little, and remark with reference to the origin of Christianity, that, as is well known, it originated among the Jews. Its origin was obscure, but those Christians who have written about it claim *that* the first fifteen bishops or overseers of the church at Jerusalem and at Pella, were all circumcised Jews, who,

in their new system, united the Mosaic ordinances with the doctrines of Christ; that at the time of the Emperor Hadrian, say about 130 A. D., this church first chose a Gentile for its bishop, and that, on this account, a good number of the members, who before were called Nazarenes, seceded from it, and were, in consequence of their separation, contemptuously called by the Gentile Christians, Ebionites, that is, beggarly people or paupers. Now, these Nazarenes, contemptuously called Ebionites, did according to Eusebius, a historian of three hundred years later, believe in the principles of a man named Jesus, who had suffered crucifixion, and who, they said, had differed from other men only by the splendor of his virtues. If, then, we take the evidence, such as it has come down to us, of those whom we should judge ought to know best, we have here, of its kind, a historical basis for Christianity, and, being as assured as we are of the certain manifestation in the flesh of the Son of God, who is He that is past, present and to come of the expanded canonical New Testament, we need not worry ourselves overmuch with such metaphysical speculations and distinctions as for long ages perplexed the Christian Church, but, exercising our Christian liberty within morality and law, as we have done in this discourse in investigating and demonstrating the truth concerning the cosmical phenomena, we should rather cultivate the spirit of Christ in ourselves than pay too much attention to the letter, and, arrayed under His banner, should fight manfully against the flesh and the devil, and all that wicked world of the natural man which, in the original Greek Testament, is generally termed cosmos.

1. The reasoning on Causation (pgs. 486-489) should, I think, have the effect of dispelling skepticism from the mind of those who are disposed to doubt the existence of the motions of the earth and the heavenly bodies; for, if we have motions which we think we know how they are produced, but really do not, and still allow that they exist by cause, then would it not be absurd to deny that the cosmical phenomena of day and night, and the seasons, etc., are brought about by motions effected by the same Almighty and Omnipresent Cause? These phenomena are to us, doubtless, "instruments, occasions and signs," but they are none the less real effects of the Creator's powers.

THE GREAT PYRAMID.

A LECTURE DELIVERED BY THE AUTHOR ON SEVERAL OCCASIONS TO
VERY APPRECIATIVE AUDIENCES.

The Great Pyramid of Egypt has, from time immemorial, been regarded as one of the seven wonders of the world. It is situated in latitude 30° north of the equator; and in what is considered the geographical center of the land distribution of the northern hemisphere. There are in that vicinity in the Nile's valley about thirty-seven pyramids, but this at Gizeh is the largest, that after which, at least externally, they have all been modeled and of which even externally none of them is a complete counterpart. As to its interior it is eminently peculiar and unique, so much so, indeed, in the light of history, science and prophecy, as to fairly win from us, moderns, the name of the Great Pyramid. There is some reason to believe that other pyramids have been used as burial places of kings and perhaps of others, but this at Gizeh was not used for that purpose for even the king under whose rule it was built, is buried, as Herodotus tells us, in a kind of island surrounded by a trench of water brought from the Nile, about one thousand feet south south-east of the southeast foot of this pyramid.

The pyramids of Egypt belong to different ages, supposed from B. C. 2170 to B. C. 1200. They are all more or less of the same general form. A few are not much inferior in dimensions, materials and outward finish to the Great Pyramid itself. The sacred books of the Hindoos speak of three pyramids in Egypt, this as "the golden mountain," and the other two as mountains of silver and less valuable material. It is recognized by all as the greatest as to magnitude, as to vertical height, and as to the skill and perfection of its workmanship. It is generally also recognized as the oldest of the stone pyramids. "The builders of the Great Pyramid," says Lepsius, "seem to assert their right to form the commencement of monumental history." I know not whether in saying this he had taken into consideration the proofs of ancient monumental history in this western hemisphere; but Prof. Smythe, whether correctly or not, holds that "the world has no material and contemporary record of intellectual man earlier than the Great Pyramid." Most

writers on pyramids of the old world, at least, agree that this is the oldest as well as the largest and most perfect of all. This appears to reverse the order of things as we know them to exist in relation to the arts of man. In all these arts there generally is first a series of crude attempts or imperfect beginnings, and thence a gradual advance from a less perfect to a more perfect. As with man in the morning of our race, doubtless, so with the pyramids, the most perfect comes first and what comes after is deteriorate. This may be thought to make against the theory of Darwin and for that of Adam and the fall of man. But what is theory anyway, if not an indicator whose finger may or may not point in the right direction? The way to get at the truth concerning any subject is to come to the contemplation of it perfectly unprejudiced in either or any way, resolved to accept the truth on whichever side it may appear. But it seems a settled conviction in the minds of men who have investigated or wrote upon the subject of the pyramids that the Great Pyramid of Gizeh is the original of which all the rest are more or less imperfect imitations; that, in comparison with it, they are all but unmeaning piles of stone.

Prof. Mitchell, of the United States coast survey, was sent by the government in 1868 to report upon the progress of the Suez canal. Struck with the peculiar form of Egypt's northern coast he sought for the central point of the successive curves. With the curvature of the northern coast on a good map before him he searched with variations of direction and radius until he had gotten all the prominent coast points to be evenly swept by his arc; and then looking to see where his center was, found it to be on the Great Pyramid, from which he concluded in his mind "that that monument stands in a more important physical relation than any other building ever erected by man." As some understand, Egypt is peculiar in having a border point which is in a sense its center also. At this center and at the same time border point this massive pyramid arises from a base of 13 acres to a height of 485 feet. Is this, then the altar and pillar in the midst of the land of Egypt and on the border thereof spoken of by Isaiah? (Ch. 19, 19-20.) "In that day there shall be an altar unto the Lord in the midst of the land of Egypt and a pillar on the border thereof to the Lord. And it shall be for a sign and for a witness unto the Lord of Hosts in the land of Egypt." There are two very remarkable pyramids in Egypt, that of brick at Abouseer, and this one at Gizeh of stone. The first named, that of brick being, according to Herodotus, built by

Asychis in the second generation after the stone structure was completed by Cheops; and although doubtless both of these are referred to by the prophet in this case yet many expositors express themselves as of the opinion that the altar and pillar referred to in the prophecy both point to the same pyramid. They consider the language poetical, that is, as having the common parallelism of Hebrew poetry. According to these a fair representation of the original would be: "In that day there is an altar to Jehovah in the midst of the land of Egypt; even a pillar upon the border thereof to Jehovah; and it shall be for a sign and for a witness to Jehovah of hosts in the land of Egypt." They consider that there is no other of the pyramidal monuments to which, the terms of this prophecy can be so strictly referred as to the stone pyramid of Gizeh, and this consequently has with them to do the work of the two pyramids really referred to, that of brick being not as yet thoroughly explored. Josephus, in his *Antiquities* (Book 1 ch. 2), relates as matter of history that "Seth and his descendants were the inventors of that peculiar wisdom which is concerned with the heavenly bodies and their order," and "that their knowledge might not be lost they *made two pillars*, the one of brick, the other of stone, to preserve their discoveries." And he adds: "Now *this*" (which the said expositors suppose he refers to the pillar of stone, but may easily be a MSS. misprint for *these*) "remains to this day in the land of Siriad."

This appears to bear the impress of truth from the fact that history informs us that the Egyptians were, in the early ages, very far advanced in astronomical and general scientific knowledge, and from the further fact that Seth is an Egyptian and Hebrew form of the Greek Σκυθ in Scythian, which by the way, is the genitive or root Scut of Scot. The Sethians or Scythians of Egypt were Egyptians of the Sethian stock, and as to whether they were or may be considered aboriginal or derived from other lands to the land of the Nile, I will say something in my peroration. I may here remark, however, that Siriad equals Sethsland, equals Sothisland, the land of Sirius, the dog-star, and this shows that the name Siria of today, extended in those early times over Egypt also; and I may say further that if the pyramid at Gizeh be the stone pillar Josephus refers to, which is altogether probable, then he may be justly thought to have put the time of the building of this pyramid anterior to the date given for the occurrence of the deluge by our Biblical interpreters. I have a great desire that the brick pyra-

has defaced the pyramid, especially as to its corners and casing stones, but the socket-holes, eight inches deep, sunk originally at the corners, and called "corner-sockets," tell exactly the base corners. By means of these not only have the foundation sides of the building been measured and their original lengths formed, but it has been scientifically ascertained that in laying off the base they oriented the work, that is, laid it off in accordance with the four cardinal points of the compass, due north, south, east and west. An astronomer, speaking in relation to this, says: "When we find that the orienting of the pyramids has been effected with extreme care, that in the case of the Great Pyramid, which is the typical edifice of the kind, the orienting bears well the closest astronomical scrutiny, we cannot doubt that this feature indicates an astronomical purpose as surely as it indicates astronomical methods." Indeed, our astronomers generally admit the true orientation of the Great Pyramid; they all admit that this feature indicates astronomical methods; all, therefore, should soberly and gracefully admit that those astronomical methods were known to the men of over forty centuries ago, although some may keep boasting of them as the result of modern thought, improvement and progress.

Thus accurately oriented they raised the pyramid to a height of 485 feet. They laid, in the construction, 209 courses of stone in horizontal layers, one layer above the other with such exact position of angles of inclination that the height of the pyramid being in a certain proportion to the base sides and other parts the requirements of different mathematical problems should be met. These courses differed in thickness or height, doubtless according to architectural rule. The first and second courses cannot be accurately measured on account of the accumulated rubbish; the third is 4 ft. and 8 in. and the fourth 4 ft. thick. As far up as the 34th course the blocks are 3 ft. thick and the 200th is nearly 22 inches. These stones are said to have been obtained in the Arabian quarries, where they were cut and finished according to measure and adaptation and then transported in boats on the Nile's waters to the causeway leading to the Gizeh Hill. It is said that some of the iron tools, used in the preparation and building, were found by Col. Vyse imbedded in the cement in the hollows of the pyramid and that these are now preserved in the British Museum.

The preparation and transportation of the stone and the construction of the causeway and the pyramid are said to have taken the labor of 100,000 men for 30 years, the men being relieved every

three months. "On the outside of the pyramid," says Herodotus, "were inscribed in Egyptian characters the various sums of money expended in the progress of the work for the radishes, onions and garlic consumed by the artificers. "This, as I well remember," says he, "my interpreter informed me amounted to no less a sum than 1600 talents." "If this be true," he continues, "how much more must it have necessarily cost for iron tools, food and clothes for the workmen, particularly when we consider the length of time they were employed in the building itself, adding what was spent in the hewing and conveyance of the stones and the construction of the subterranean apartments."

Although it is evident from this that Herodotus calculated that all this work was done by forced labor, yet reckoning the Attic talent, which is most likely to have been that after which he reckoned at somewhat over \$1,100, then the sixteen hundred talents would equal considerably over \$1,760,000, which would imply the whole cost of the structure to have been in such circumstances and for that age considerable. The blocks of stone "none of which was less than thirty feet long" and one of which it would take on an average 200 men to raise the $\frac{1}{8}$ th of an inch from the ground, were lifted high in the air and swung into their destined places with the nicest exactness and there skillfully cemented together. "The ascent of the pyramid," says Herodotus, "was regularly graduated by what some call steps and others altars. Having finished the first flight; they elevated the stones to the second by the aid of machines constructed of short pieces of wood; from the second, by a similar engine; they were raised to the third, and so on to the summit. Thus, there were as many machines as there were regular divisions in the ascent of the pyramid, though in fact there might be only one, which, being manageable, might be removed from one range of the building to another as often as occasion made it necessary. Both modes have been told me and I know not which best deserves credit. The summit of the building was first of all finished; descending thence they regularly completed the whole." Thus speaks Herodotus, the so-called "Father of History" on account of his antiquity, whose researches in Egypt are said to have been begun in the year 445 B. C. He is our chief authority on the subject of Egypt at that early time and also a very principal authority on the subject of the pyramids.

The base of the pyramid, measuring 13 acres and a fraction, was laid off in a perfect square of which each side was 9,130 British

inches. This is the original length of the base side as measured from the corner socket-holes as dilapidations have abridged the length in the building itself by several feet. It is necessary to explain, however, that the British inch could not have been the unit of measure used by the architects of the pyramid. But it is found there was a unit of measure, the inch, which differed almost or quite imperceptibly from the British standard. Now each base side measures 9,131.05 of those pyramidal inches and the obtaining of this length of the side was essential to the solution of some of the most important problems in nature; the year's true length, that of the precessional cycle, the quadrature of the circle and the sun's distance from the earth. I need to remark as to measures that the inch, hand-breadth, span, foot, cubit and yard or pace are all derived from the human form; but as human hands and thumbs and feet and length of step and arm differ in extent, these are not invariable as true standards of measure. But there is a unit of measure, an inch, relating to the earth's polar axis which is the $\frac{1}{10000}$ th part or a very fine hairbreadth longer than our common inch; that is to say the length of the earth's polar axis is, according to the British ordinance survey, five hundred millions, four hundred and twenty-eight thousand and two hundred and ninety-six of our inches. Beckett Dennison, however, in *his* astronomy gives 500,500,000 inches as the length of the earth's polar axis, this as the mean result of the most reliable modern calculations. Now, this would make just five hundred millions of those inches which were the unit of measure in the plans of the Great Pyramid—an inch which is *the one one-thousandth part* longer than the British inch. From this it would appear that "God who continually geometrizes," as Plato says, laid off the earth's central line from pole to pole by the inch marked in the measures of the pyramid. It, at least, appears certain that the inch or unit of measure in the pyramid, that which measures its various dimensions without fractional remainders and with corresponding adjustments, is the inch which measures the earth's polar diameter without a fractional remainder. Moreover, it is found that twenty-five of these pyramidal or earth-measuring inches constitute the length of the sacred cubit of the Hebrews. The Babylonian, Persian and Egyptian cubit was from 4 to 5 inches less than the *sacred cubit*. There is in the Scriptures a distinction marked between the sacred cubit and the "cubit of a man," for we read of the iron bedstead of Og, the King of Bashan, being nine

cubits, the length thereof, and four cubits, the breadth thereof after the cubit of a man" (Deut. iii: 11). In Ezekiel's vision of the Temple we read: "And these are the measures of the altar after the cubits. The cubit is a cubit and a hand-breadth." That is the sacred cubit is a man's cubit and a hand-breadth. And again: "Behold a wall on the outside of the house round about and in the man's hand a measuring reed of six cubits, by the cubit and a hand-breadth," (Ez. 40, 5; 43, 13). Hence it is clear that the sacred cubit differed from the cubit of a man by about 4 inches, the Egyptian cubit being nearly 21 of our inches.

Two centuries ago Sir Isaac Newton demonstrated by *seven* different processes from ancient data *that the Israelites had a sacred cubit before they went down into Egypt*. He proved that this cubit was longer than the Egyptian one by several inches and that the sacred cubit was treasured up by Israel and employed for sacred purposes only. The length of this cubit Newton made out to be $25\frac{7}{100}$ ths of our inches, with a possible slight error on one side or the other. That is, he deduced the limits of its length as in no case less than 23.3 or more than 27.9 of our inches of which and of his other numbers 25.07 is the mean. This approximate length of the sacred cubit has been determined by more recent calculations to be exactly 25.025 of our inches.

There is in one of the interior rooms of the pyramid, that called the Queen's chamber, a sunken niche which unmistakably marks this sacred cubit. It is not in the central vertical line of the wall but is southward therefrom, just the exact quantity of the sacred cubit. This niche was evidently sunk there to mark off the 25 inch sacred cubit, that is, *five times five* of those inches of which five hundred millions measure the earth's polar axis; and it appears quite evident that these measures were in the minds of the architects of the pyramid and were meant by them to be significantly emphasized, I mean the inch and cubit of those measures.

Now, taking the accurately measured length of each side of the pyramid's base, that is, 9131.05 inches and dividing this number by the sacred cubit, marked off on the wall of the Queen's chamber, the quotient is 365.242, which reduced to days and fractions of a day amounts to 365 days, 5 hours, 48 minutes and 29 seconds. Thus we find the days, hours, minutes and seconds composing our solar or tropical year to be stamped upon the stony leaves of this massive pyramidal book, and that, in this computation, the sacred cubit represents the day. But, besides marking off the base side

of the pyramid so that it should number just as many sacred cubits as there are days in the year, the builders so shaped its corners from base to summit that its height should represent proportionally the sun's distance from the earth. The pyramid has that angle of slope at its sides which brings out the proportion of a circle to its diameter known as π . Thus, for every 10 units which the structure advances inwards it rises 9 of the same units sunwards. For one to have a somewhat clear conception of this let one imagine himself standing at any corner of the pyramid and looking up toward the top; the distance inward, at each step at this corner is necessarily greater than the distance inward at the sides of the building and the slope is less steep all the way to the top. Now, this corner slope is at an angle of $41^{\circ} 59' 18.7''$ while the slope of the sides inward is at an angle of $51^{\circ} 51' 14.3''$. This latter angle was essential to the proportion of a diameter to its circumference, the other to the proportion of 10 inches inward to 9 sunward. And so this 10 by 9 proportion is stamped upon the pyramid's receding and ascending layers as it was also on the casing stones which at first shielded it from base to apex.

The thicknesses of the pyramid's horizontal layers of stone, beginning at the base with fifty inches, gradually diminish to about 35 inches at the 35th course. But here they immediately thicken again, so that the 36th course begins with a 50 inch thickness and again the courses proceed in the same manner.

Now, for the reason of this: 35, that is 7 times 5, is an important pyramid number. While the 35th course attains a vertical height above the base of 1162.60 inches or ten times the length of the antechamber of the king's chamber at this point of height in the middle of any side the horizontal distance to the vertical axis of the pyramid is 3652.42 pyramidal inches, that is, the number of days in the year when multiplied by 10. While further in this case two straight lines are given to show the proportion of the circumference of a circle to its diameter; for 3652.42 divided by 1162.60 equal 3.14159+ which is π . And, finally, 11626.02 or ten times the height of the 35th course or 100 times the length of the antechamber represents, in terms of the earth's polar axis, the sun's distance from the earth.

Allow me to explain that in the Egyptian language *perumi* signifies a man, which Herodotus has *pyramis*, genitive or root pyramid. Some philologists, including Bunsen, consider the word pyramid to be derived from the Egyptian *pe-ram*, signifying "the lofty" or

“the high,” that is, doubtless, anything lofty or high including the celestial objects. Others suppose it to be made up of peres, interpreted by Daniel “division” and “met” meaning 10, and although this is altogether less likely to be the correct derivation, it is nevertheless certain that the number 10, especially in its division 5, is so marked in the pyramid as to lead one to suppose its builders must have known and practiced the decimal system. There are five sides, counting the base, and five corners, which, of course, includes the apex or corner stone proper.

Now this is the place for me to say a few words as to the apex or corner stone. While this building stands on a rock whose depth has never been reached, it is or was when perfectly finished (although it is not now), surmounted on the top by a capstone which is the head and finishing stone of the structure. This is called the corner-stone. In no other kind of building could the corner-stone be the head or capstone. It pertains peculiarly to the pyramid. To this kind of building with such corner-stone reference is evidently made in such passages of Scripture as, “The stone which the builders rejected is become the head of the corner.” This lofty corner-stone of the pyramid must be in the shape of a pyramid itself. The whole structure must be raised with a view to this corner. It may be said to be built up into this corner as God’s people are said to be built up into Christ. It is different from any other stone in the building. Those are square, or cubical, or rectangular, or polyhedral in some other way; this single one has all its angles acute, all sharp points. It has five sides, five corners and 16 distinct angles. It might well, therefore, be to the workmen a stone of stumbling and a rock of offense. Whoever should fall on it would be broken or cut and on whomsoever it should fall (from its immense height), it would grind him to powder. Some might think that when it rested in its place it was a pyramid on a pyramid; but not quite so: the building, without it, was not a complete and finished pyramid (although it is, in its way, a pyramid itself and perfects the building into a pyramid).

The number 9 may also be thought to be significantly marked upon the pyramid, more especially in the interior measurements, and as a factor of them. But I have said that the corners recede inwards 10 units for every 9 which the building rises sunwards. Now this 10 by 9 indicates 10 raised to the ninth power, which equals one thousand millions, or a billion, and this

result multiplied by the pyramid's height and reduced to English miles gives the sun's distance from the earth, which in round numbers is, by this process, found to be 91 millions, 840 thousand miles. Until within the last 10 or 15 years the sun's distance was reckoned in round numbers at 95 millions of miles, but later results make its mean distance two or three millions less. It is very likely that the result of the pyramid calculation is not far from the truth; for the general scientific result from the observation of the transit of Venus in 1874 was 91,840,271 miles, which is nearly the same. And it is seen that the height of the pyramid, 5,813 inches, multiplied by one thousand millions or ten to the ninth power makes only 271 miles difference. When the result of the general scientific computations was announced in the Paris journal, *Le Monde*, the editor accompanied it with the exclamation, *La Grande Pyramide a vaincu*. Thus far the Great Pyramid gives us the measure of the earth, giving us its diameter from which we can make the calculation, and then it gives our distance from the sun with, doubtless, as great definiteness. It also gives us in the length of the side of the base the days, hours, minutes and seconds of our solar year. But there is a much more comprehensive movement than anything we have yet met with observable in our earth relatively to the heavens, and this is called the precessional cycle or the precession of the equinoxes. In the words of Prof. Olmstead (speaking of this movement of the earth): "The appearance is as though the equinox goes forth to meet the sun, and hence the phenomenon is called the precession of the equinoxes. The scientific explanation of the fact is by saying that the equinoxes retrograde on the elliptic until the line of the equinoxes makes a complete revolution from east to west." This retrograde movement around the complete circuit of the heavens is at the rate of about 50.2 seconds in a year, so that it requires 25,827 years for the cycle. By reckoning backwards it is found that the constellations and signs of the zodiac coincided with each other about the year 370 B. C., so that reckoning forward from that date you may compute the precessional year at 25,827 years when the constellations and signs of the zodiac will again coincide. Now, wonderful to relate, the added lengths of the two diagonals of the pyramid's base are found to be 25,827 pyramidal inches, which number is equal to the mean result of the somewhat varying calculations as to the length in years of the precessional cycle.

Moreover, this great cycle is plainly indicated in the contour

of the pyramid by way of its upper or principal room called the king's chamber. The floor of this room is 1,702 inches above the foundation and it has been shown that the circuit of the pyramid at the level of this room equals 25,827 pyramidal inches. These facts, in regard to the precessional cycle, make it the grand chronological dial of the Great Pyramid and this pyramid itself the great standard of time measure. By it Sir Jno. Herschel told when it was the star Alpha Draconis looked down its descending passage which, taken in connection with some inside markings is supposed to tell the date of the pyramid's construction.

If we add together the number of inches in the four sides of the pyramid's base or, which is the same, multiply the base side length by 4, we have 36524.20, and, if we divide this by 100, we have 365.242 or the length of our solar year, so that 100 inches in the pyramid's base side is shown to represent the length of the day. This is, also, apparent throughout in the interrelations of the pyramid's measurements.

The only entrance known into the Great Pyramid, as left by the builders, is a low and narrow square passage which begins high up on the north side and runs obliquely down to an unfinished room in the solid rock on which the pyramid stands. The size of this passage is not quite 4 feet high and a little over 3 feet 5 inches wide. A man needs to stoop considerably to pass through it and to take heed to his steps by reason of the steep incline originally finished with great smoothness from top to bottom. The first *upward* passage is directly over the entrance-tube and is of the same general dimensions and character. It follows the same direction from north to south and conducts to a high, long and beautifully finished opening whose floor-line is continuous and at the same angle of incline with the passage of ascent to it. This is the Grand Gallery, 28 feet high, each of whose sides is built of seven courses of overlapping stones. It is covered by 36 large stones stretching across the top. It is 1881 inches long and suddenly terminates against an end wall which leans a little inward. The onward opening is low and small again, leading into a sort of narrow ante-room, in which a double and heavy granite block hangs from grooves in the side walls. Then follows another low entrance leading into the apartment called the King's chamber, the highest and largest known room in the edifice. In this chamber stands the only article of furniture in the building, the celebrated granite coffer. Above this room are shown what are called chambers of construction, indicating how the builders

arranged to keep the weight of the superincumbent mass from crushing in the ceiling of the king's chamber which ceiling consists of powerful blocks of granite stretching across. (The dark or crossed shading about this chamber indicate the stones to be granite, all the rest of the building not so marked is of light limestone.) This room is ventilated by two tubes running from it to the outer surface.

Directly under the Grand Gallery and running in the same direction from north to south is a *horizontal* passage which starts on a level with the entrance into the Grand Gallery and leads to the apartment called the Queen's chamber. The floor of this room, if it may be called a floor, measures 205x226 inches, stands on the 25th course of masonry as the King's chamber stands on the 50th. It has a pointed arch ceiling. Though excellently finished this room has no ornament. There is a ledge marked evenly round its sides at the height of the passage of entrance and a remarkable niche in its wall, which I have mentioned before as measuring exactly the sacred cubit. I have said that the Grand Gallery, measuring 1881.4 inches, is on a continuous inclined ascending plane with the passage of 1542 inches in length which leads up to it. Now at about 34 inches, or less than one yard, from the commencement of the Grand Gallery, on the west side, is an opening or mouth of a hole which runs irregularly and somewhat tortuously down through the masonry and natural rock till it strikes the main entrance a short way above the subterranean chamber. Nearly half way down it expands into a rough grotto or wide bulge in the opening making a large, irregular, subterranean bowl. Below the entrance passage and a little to the west of it is the passage made by the Caliph Al Mamoun in 825 A. D. in his hunt after treasures. He cut this passage not knowing there was an open one not very far above.

Now, as to the entrance passage proper, its transverse height is found to be 47.24 and its vertical height 52.76 inches. The sum of these two heights taken up and down equals 100 inches, and the mean of the two heights, or the height taken one way only and impartially to the middle point between them equals 50 inches, which quantity is taken as the general pyramidal linear representation of half a day, as we have found 100 inches in the pyramid's base side to represent a day. In this case it has been considered what the entrance passage has to do with a half a day rather than a whole day. It was found that the axis of the passage pointed not

to the one central pole of the sky nor to the upper culmination of a star revolving about the polar point but to the lower culmination of the same. And from this pointing it was theoretically concluded that the architectural reason for having the passage point to the lower culmination only was because a more important star was contemporaneously passing at its upper culmination or crossing the meridian above the pole. From computations in relation to this, which Sir Jno. Herschell and others thought it worth their while to make, it was found that at or near the two dates 3440 and 2160 B. C. the star A of the constellation Draco passed the pole at its lowest culmination, and that contemporaneously with this passage, at the latter date but not at the former, was the passage above the pole of the star Alcyone of the Pleiades in the constellation Taurus. At these two dates did Alpha Draconis pass below the pole so as to be vertical to the axis of the entrance passage of the pyramid, and so in connection with some inside markings, the year 2170 B. C. (being a mean of 2170 and other years) has been theoretically set down as the probable date of the erection of this pyramid.

The new theory concerning the pyramid, first mooted publicly by Mr. John Taylor, of London, in 1859, and then favored generally by Prof. Smyth and others, involves the idea that the interior passages and departments are also time charts, symbolizing ages of human history. The inch as the unit for a year appeared in those avenues. The entrance downward passage is supposed to date from the formation of nations after the confusion of tongues at Babel. The passage with its history is remarked to be a downward one under a Dragonic star towards a bottomless pit. Following this decline for about 988 inches, we reach the first upward passage. At this point of time the Israelites are supposed to have begun their national economy and history. Then again, following this ascending passage 1542 inches, the number in years reckoned from the expulsion of the Shepherds from Egypt to the birth of Christ, the last inch brings us to the commencement of the Grand Gallery, which symbolizes the Christian dispensation. Counting back, then, from the beginning of this gallery, that is, from the birth of Christ, 1542 inches to the entrance passage and then up the entrance passage 628 inches more (all representing years) we have $1542 + 628$ equals 2170 years Before Christ, the supposed date, according to this theory, of the erection of this pyramid. At this point is found a distinct and beautifully cut line ruled in the stone sides of the passage from top to

bottom, put there by the builders. That those stones were meant to mark the time of the pyramid's erection, the indication is thought to have been given in the joinings of the two stones next preceding these being vertical to the incline instead of at right angles as are all the rest. And immediately after the vertical joinings come these five lines just 2170 inches from the commencement of the Grand Gallery, which, as the beginning of the Christian dispensation would represent the time of the birth of the Christ. If this theory be well grounded and the supposition of the intended meaning of the vertical joinings (which taken in connection with the astronomical indication of the entrance passage's pointing in a peculiar way to a polar star, is the only indication which I know of to substantiate it and may be thought a telling one), if this theory, I say, be well grounded, then this pyramid tells its own age in the same manner as it tells celestial distances and cycles and the succession of events and dispensations on the earth. I have seen it stated in some book I have read on this pyramid, that if we trace back 620 or 630 years before the supposed time of the pyramid's erection, or say to 2800 B. C., that we shall find the same star Alpha of the Dragon, vertical to the axis of the entrance passage, and that contemporaneously there was upon the meridian above the pole the constellation of Aquarius or the Waterman. Now, without noticing this statement farther than as to the position of Aquarius for 2800 B. C., a consideration of the relation of the constellations to the signs of the zodiac will show us this could not have been so, but, even if it were, it could only be supposed to indicate that there might have been a flood, whether local or universal, or say, remarkably rainy weather upon the earth for a season, at about the mean of the two dates given for the occurrence of the deluge in the two different versions of the Scriptures, the Hebrew and the Septuagint; the mean of all the dates given for which event would be about 2800 B. C.

As to time reckoning some other system than the decimal appears evidently in place. The year and the day are such distinct units of nature that man is compelled to observe them in his notations and they will not subdivide or multiply into each other very easily by decimals. The French savants tried it but had ultimately to fall back upon the old week of seven days. We would, therefore, expect this great symbol of nature, the Great Pyramid, to have some reference to this also and in spite of its intense *fiveness* it does

not fail to present the system of *sevens*. Hence, the Grand Gallery is seven times the average height of the other passages and its sides are built of seven overlapping stone courses on either side. So the passage which leads horizontally under it to the Queen's chamber has a section distinctly, though differently, marked off at its end, which is the *one-seventh* of that passage's entire length. But this is not only septenary, it is likewise sabbatic, that is, the Queen's chamber and the way which leads to it. There is a seventh marked off from the sixth and especially emphasized. The last seventh of the horizontal way to that chamber is deeply indented in the floor so as to make the perpendicular height of the passage there about *one-third* greater than anywhere else. This alone would be decisive; but the chamber thus approached through a sabbatic avenue is itself the culmination of a sabbatic system. By reason of its peaked and two-sided ceiling it is a seven-sided room, and the amount of cubic space thus divided off above the square at the top is the seventh of the cubic space contained above the distinctly marked base line, which runs round the room at the height of the passage conducting into it. It is by its intense sevenness or sabbatism that this department of the building is identified with the Jewish like as the Grand Gallery with the Christian dispensation.

The solution of the problem of the squaring of the circle has always interested mathematicians from long before Archimedes to the present time; but this problem of the ages is solved in the Great Pyramid. It consists, as I have before indicated, in finding a square equal to a circle the radius of which is known. Now, the pyramid is just such a height consequent upon its particular angle of slope that this its vertical height is the *radius* of a circle, which circle equals the four sides of the base, thus practically and beforehand solving the problem of the after ages. For this angle of slope from the base upward gives such a height to the structure as must necessarily result from it. It is easy, therefore, by finding where the angles of slope would meet each other to calculate what was the original height of the structure. This has been found to have originally been 5813.01 pyramidal inches. Twice this would be the diameter of a circle, *which circle* would be equal in lineal extent to the sum of the four sides of the base. The question to be solved by the architects of the pyramid was: what proportion does this diameter bear to the square formed by the four sides of the base? Well, the four sides of the base each equaling 9131.05

inches make 36524.20 inches. The diameter of the required circle, twice the vertical height of the pyramid, which is 5813.01×2 inches = 11626.02 inches. Now, to ascertain what proportion this diameter bears to the four sides of the square the former or greater number is divided by the latter or less number and the almost magical and now universally recognized number $3.14159+$ is the quotient. This is the celebrated π in which for all practical purposes the problem is solved, the proportion of a diameter to a circle and of a square equal to a circle being expressed in the vertical height, as radius, and the four base sides of the pyramid in language which is simple and which will last as long as men exist. Moreover, it was discovered by Capt. Tracy in 1873, that the pyramid inches in what is termed the King's chamber, stand for cubits outside the pyramid.*

The 36th horizontal course of stones in the Great Pyramid's structure is, as I have mentioned before, remarkable for being nearly

* From this the following results have been deduced: Take the length of the King's chamber or 412.132 inches, as the side of a square, and throw it into a circular shape; the radius of such, a circle will be found to be the height of the Pyramid in cubits, viz., 322,520, thus expressing in another way the remarkable fact that the Pyramid's height is the radius of a circle, which circle is equal to the sum of the four sides of the base. Further, take the circuit of the north or south wall of the king's chamber in the entirety of the granite, and divide it by that chamber's length and the result is π . Thus, by substitution we find that long rectangular room, through the agency of π , to answer intellectually to the square-based and five-pointed exterior exponent of the same proportion. And in the ante-room of the King's chamber the same relation to the π proportion is to be traced. Thus, the entire length of the Antechamber floor, multiplied by π gives the number of days in a year. The number of cubic inches contained in the granite leaf which hangs across the Ante-chamber, measured to the edges of the dressed surfaces, is 10,000 π . The uses of the East wainscot of the Ante-chamber in being lower than the west wainscot and just half the width of the King's chamber are apparent. This is, 1st, equal to the length of the *granite* in the Ante-chamber floor and to the length of the side of a square whose area is equal to that of a circle, drawn with a radius of the whole length (granite and limestone) of the floor. The whole length of the Ante-chamber floor is 116.26 inches, being made up of 103.033 of granite and 13.23 of limestone; and 116.263 is found to be the diameter of a circle having equal area with a square whose side is 103.033 of granite, 2d. 103.033×5 (a pyramid number) = 515.165, or is the length in Pyramid inches of the cubic diagonal of the King's chamber. 3rd. 103.033×50 (the number of masonry courses the chamber stands on) = 5151.65 or is in Pyramid inches the length of the side of a square of equal area to a triangle of the shape and size of the Great Pyramid's vertical meridian section. 4th 116.260 (the whole length of the Ante-chamber) $\times 2 = 232,520$ in inches, nearly the mean of the first and second heights of the King's chamber, or in cubits the vertical height of the pyramid. 5th. $116.260 \times \pi = 365.242$ or the number of days in the solar year. 6th. $116.250 \times \pi \times 5 \times 5 = 9131.05$ or the length in inches of the base side of the Pyramid. 7th. $116.260 \times 50 = 5813.01$ or in pyramid inches the vertical height of the pyramid. Hence, it must be seen that the particular height given to the east wainscot was not for no purpose; and as to the particular height given to the west wainscot of 111.8 inches we may be sure that the architect meant something by that also; for, if we divide this height 111.8 by 100 and call the original quantity now 1.118 or 1.11803, then we find the breadth of the King's chamber multiplied by 1.11803 = the height of the same: Hence if the breadth of the King's chamber be 1 the height is equal to 1.11803. The height of the Ante-chamber 149.3 or .4 inches = the length of the base side of the pyramid plus the vertical height of the pyramid divided by 100. So, again, the length of the first ascending passage plus the length of the Grand Gallery, divided by π , gives the length of the entrance passage from the original surface of the Pyramid to the first ascending passage.

double the thickness of the courses immediately below it. The base of that course is just 10 times the height of the ante-chamber; and the distance from the vertical center of the edifice to the nearest point of either side at that height, divided by 10, gives the number of days in a year, and the same divided by the vertical height at that point is π . A circle with the breadth of the coffer's base for a diameter or a square with the depth of the coffer for its side, gives the external area of one of its long sides divided by π . So, again, in the interrelation of the several main parts of the pyramid as a whole, the King's chamber and the coffer. In each of these three one rule governs the shape of each, namely, the two principal dimensions added together are π times the third. Thus, the Pyramid's length plus its breadth equals π multiplied by its height. The King's chamber's length plus its height equals π multiplied by its breadth. The coffer's length and breadth equals π into its height. These and numerous other such propositions relating to this subject have been thoroughly wrought out by competent mathematicians and those competent to perform the necessary operations may verify for themselves by referring to the actual measurements. No one, therefore, who gives a fair degree of attention to this subject can deny the use and application of mathematical ideas in all the arrangements for and the construction of this pyramid and in all the interrelations of its departments.

There has been much labor expended by modern science to find out the mean density or specific gravity of the earth without exactly solving the problem. The best attested experiments make it between 5.316 and 6.565 times the weight of water at the medium temperature of 68 deg. Fahrenheit. The Great Pyramid makes it 5.7 which is almost exactly the mean of the best five experiments ever made. A further memorial of the same is furnished in the coffer of the king's chamber, in whose structure the same π proportions of the pyramid itself appear in another form. The internal capacity of that coffer is by the nicest possible computations, 71.250 cubic Pyramidal or earth-measuring inches. The only intelligible reason for that particular capacity is to be found in the combination of a capacity and weight-measure-standard having reference to the size and specific gravity of the earth, with that gravity computed at 5.7. Even the long unnoticed irregularities of that coffer come in as a necessary modifying element to meet precisely the earth reference formula. On the Pyramid's system of *five*s 503 earth-measuring inches, multiplied by the earth's specific gravity

and divided by 10, represent with close exactness the coffer's interior capacity. This coffer, therefore, comes in as a seal to the reality of the earthly references at the valuation given, and at the same time furnishes a grand standard of combined weight and capacity or space measure. At the rate of 5.7 for the mean density of the earth the coffer's contents of water at 68° Fahrenheit would be equal to 12.500 cubic inches of the mean body of the earth. Dividing this into 2500 equal parts for a small fraction in the dominant pyramid number we have an even result, equal to five cubic inches of the earth's mean density, which would be the pyramidal or earth-commensurating *pound*, which is within a small fraction the same as *our common avoirdupois pound*, equal in weight to a pint, (5×5.7 cubic inches) of water at a temperature of 68° Fahrenheit.

As I have remarked before, the only article of furniture in the whole Pyramid is this coffer in the king's chamber. It is in shape an oblong, rectangular trough, without inscription or ornament, and of such a size that it could not possibly have been taken in or out of its place since the pyramid was built. Its proportions are all geometrical; its sides and bottom are cubically proportional with its internal space. The length of its two sides to its height is as a circle to its diameter. Its exterior volume is just twice the dimensions of its bottom, and its whole measure is just the fiftieth part of the size of the chamber in which it stands. Its internal space is just four times the measure of an English quarter of wheat. Its contents measure also correspond to the length of the sacred cubit of 25 earth-measuring inches. The Holy Ark of the Tabernacle and Temple was according to Scripture $2\frac{1}{2}$ cubits long and $1\frac{1}{2}$ broad and high. This, doubtless, is *outside* measure, as the records speak of *height* and not of *depth*. With 25 earth-measuring inches to a cubit and allowing 1.80 of those inches for the thickness of the boards, its internal space would be 71.282 of the same cubic inches, or within 32 of the number of such cubic inches in the capacity measure of the pyramid coffer. Or allowing 1.75 inches for the thickness of the sides and ends and two inches for the bottom, the internal cubical contents would be 71.213 cubic inches or within 37 of the coffer. The mean of these two estimates, which must include all reasonable suppositions for the carpentry dimensions of the Ark, would be 71.248 cubic inches, which is within two cubic inches of the best computation of the internal dimensions of the pyramid coffer. That they should be thus alike in

their internal dimensions is remarkable, and that the two should thus mutually sustain each other in the recognition of one and the same earth-measuring cubit is both striking and significant. Further, using this same earth-measuring cubit as identical with the sacred cubit, the further result appears that the Jewish laver and the Ark of the Tabernacle were the same in capacity-measure with the Pyramid's coffer, and that Solomon's Molten Sea was just fifty times the capacity of either of these and exactly equal in interior cubic space with the king's chamber itself.

And now as to temperature: As the Great Pyramid stands on the line which equally divides the habitable land and sea surface of the northern hemisphere there is in it a close approach to the mean temperature of all the earth's surface. According to the French scientists from observation both inside and outside of the pyramid that temperature is about 68° Fahrenheit. A permanent and unvarying record of this temperature is kept in the Pyramid's Granite Chamber, which is so buried in masonry as not to be affected by external changes and furnished with a system of ventilating tubes to keep everything exactly normal within. This degree of temperature is indicated by exactly 1-5th of the distance which mercury rises in the tube between the freezing and boiling points of water, and furnishes the basis for a complete nature-adjusted pyramid system of thermal measure. Dividing this one-fifth by the standard of fifty (the room in which the index of temperature is arranged being the chamber of fifty) we have the even 250 for the degrees between the two notable points of nature marked by the freezing and boiling of common water. Thus while the great standard of nature is 68° Fahrenheit, that is, the temperature of the earth in which man operates with most ease and comfort, we have 0° as the freezing point of water; 50° mean temperature of *the whole earth*; 250° boiling point of water; $1,000^{\circ}$, that is $250^{\circ} \times 4$, the point at which heat reddens iron; and $5,000^{\circ}$ (that is, $1000^{\circ} \times 5$) white heat, the point at which platinum, the densest of metals, melts. Thus, the Great Pyramid proves itself competent to determine on a natural and scientific basis all measures of weight, capacity and length.

Even the degrees of the circle, if arranged on the Pyramid numbers, say $1,000^{\circ}$ instead of the Babylonian 360° some think would be a great improvement. This would divide the quadrant into the convenient 250° with even tenths for minutes and seconds, whilst it would at the same time harmoniously commensurate with navigation and itinerary measures of knots and miles, into which it

is now so troublesome to translate from the indications of the sextant. The great standard for linear measure is the earth's axis of rotation measured by the sacred cubit of Moses and the Great Pyramid. The distance from the earth's center to either pole divided by 10^7 is equal to 25.025 English inches or 25 Pyramid inches. And there would seem to be nothing wanting in this mighty monument of antiquity for the formation of a metrical system, the most universal in its scope, the most scientifically founded in its standards, the most natural and universal in its application and use that can be employed for our earth purposes.

About the year 1865 there was broached the theory that the immense superiority in height and finish of the Grand Gallery over every other passage is owing to the fact that it represents the Christian dispensation, while the other passages represent only preparatory dispensations or human histories. This theory from its nature and apparently very good grounds soon attracted wide-spread attention. If, it was said, the Grand Gallery represents the Christian dispensation, the mark for the commencement of that dispensation is the beginning of the Gallery. Now, measuring 33 inches from the commencement of this gallery, which would represent the duration of the earthly life of Christ, we come precisely over the mouth of a hole running downwards; which hole has gotten the name of "the well." This Grand Gallery is lined along its base on both sides by ramp-stones like our wash-boards, hollow in center. They are each about a foot square and all cut with miniature symbolic graves, every one of which is open. More than this, by the side of each of those open graves is a neatly cut stone set vertically in the wall. It is a symbol of *erectness*, and almost audibly proclaims the tenants of those open graves risen, as all true Christians are not only from the death of sin, but to an heirship of a still completer resurrection through the spirit of Christ. There are 56, or 8 times 7 of these open graves; 8 is the number of new life and resurrection and 7 of perfection and dispensational fullness, so that by their numbers they also signify this newness of life.

Now, that so called "well" or open hole is caused by the absence of its ramp-stone; nor is there any good evidence that it ever had a ramp-stone, although some have thought they detected indications of it. It occurs in the gallery at a point to coincide with the Scriptural account of the death, burial and resurrection of the Christ, and is regarded as a strong point with which to begin the Christian Theory of the Grand Gallery. The length of this gallery

being a little over 1881 inches, would indicate as to the progress of years, this to be about the time when the Christ would begin to become known, as a man, in the world. It, in short, might appear to indicate such a movement forward of state or dogmatical Christianity, as we have now already long seen to have been taking place, to be culminated by the apparition on this earthly scene of a man who personated in himself true and active godliness, of a man, I say, who in the course of his labors should give to the saints some indications by which they might form correct judgments concerning the quick and dead, especially of the powers of Christendom, for it is said, "The saints shall judge the world." This interpretation is, we are aware to a good extent borne out in effect, and, however it may be as to the completion of it in the interval between this time and 1910, A. D., it is regarded as certain that this Gallery, taken in all its indications, symbolizes the Christian dispensation as emphatically pronounced as stones can speak it. This stares every one in the face the moment they enter the place. Each side wall is made up of just seven courses of finely fitted, polished stones, the one overlapping the other and extending the whole length from commencement to termination. It is the gallery of the seven courses just seven times the average height of the other passages. Besides it has special relations to the Pleiades. It tells in several ways of these benignant stars. In its own way it thus also points to the "seven stars" spoken of in the Apocalypse as presiding elders over the seven churches. Its south or further wall leans a full degree inward and overhangs its base, looking as if it might topple over at any time. This is also thought to be a portent of the judgment. From the Grand Gallery one passes into the Ante-chamber of the King's chamber. A great, frowning double stone, called the "Granite Leaf" hangs in its grooves over the passage beneath which every one who passes into the Ante-room must bow, exhibiting an impressive picture of "the great tribulation" of the judgment period. There are also the rules and measures by which the pyramid was constructed, all graven on the stones, indicating the complete rectification of everything according to law and justice. And through this only can the entrance into the grand and polished granite chamber of the king, the holy of holies which contains the coffer or ark of the pyramid, be effected. In this, the king's chamber, all consummates. There the polished red granite walls and the grand proportions of this exalted place eloquently tell of glories yet to come. It is the chamber of fifties which is the grand

jubilee number. The granite blocks, 100 in number, look calmly on from every side. Stainless as the cerulean vault above is this elaborately wrought chamber. Not a hieroglyphic nor an idolatrous sign, not a sign of kingly or priestly ambition or profanation there. And thus we can estimate the character of the dispensation still ahead of us, but very near.

I have already said that the Grand Gallery which we suppose to symbolize the Christian dispensation is 1881.4 inches long; Well now at about the 1814th inch from its beginning there arises a stone step 3 feet high, and beyond this step there is no further ascent. The great stone which forms this step is the most fragile and dilapidated of all the stones in the gallery. It is thought by some theological pyramid interpreters to symbolize the Christian activities in the way of Bible distribution, missionary enterprise and the like which came so actively into existence in the early part of this 19th century.

Some interpreters have thought that the British government was symbolized by that stone, as religion must needs be connected whether in prophecy or in real history with some nation or people, and as they thought they found this fairly inferable from the height of this stone being the exact measure of the British yard. I would consider, however, that in case of such national reference, in this case at least, although the British government might be especially indicated, yet the prophetic reference would rather seem to be to the reformed governmental systems generally, consisting of state and church combined.

If we measure the inches across the step in the Grand gallery floor we have :

From entrance of Gallery to step.....	1813 inches
To top of step.....	36 " or 1 yard.
Along the step.....	61 "
Making.....	<hr/> 1910 "

altogether as against 1881.4 in the floor proper. But consequent upon the bend inward of the south end wall the length of this gallery varies at different heights so that it is only 1878.4 inches at the height of the longitudinal grooves near the lower edge of the fifth side's overlapping stone. Now, 1878.4 divided by 36, the the number of roof stones, gives 52.177+ the number of weeks in a year: And again, 365.242, the number of days in a year, divided by 7, the number of side overlapping stones, gives the same

result, namely, 52.177+, which shows the septenary computation of time to be here also provided for. 53 inches is the length of passage from the Grand Gallery to the Ante-chamber, so called because through it you have to pass to the King's chamber. This Ante-chamber's height is greater than either its length or breadth, it being 12 feet high, $9\frac{1}{2}$ long and $5\frac{1}{2}$ wide. Its sides are ornamented with what is, for convenience, called wainscoting or dado, cut in the stone walls. These walls are part of granite and part of limestone.

The double block of granite, called the "granite leaf," crosses the entrance way into the chamber 21 inches from the wall and doorway. It is set in grooves cut in the wall. The double block, that is, one block upon the other, is made to fit into those grooves nearly midway between the ceiling and the floor. It was thought at first to belong to a system of portcullis or sliding doors, as was that at the entrance of the upward passageway spoken of before, but it was afterwards found this could not be so. This double block is $1\frac{1}{4}$ feet thick and 4 feet in breadth from the grooves on the east and west walls, the part of the chamber above the grooves and wainscot being broader by 17 inches than that part of the room where this double granite block crosses it like a frowning judgment bar. And this "granite leaf" has to be met and gone under by all who go into the King's chamber. On this double block there is a jutting protuberance or bulk, which is called the *granite boss*. This is in the shape of a half moon and has been carefully formed by the workman's chisel. It is exactly one pyramid-inch thick and five of the same inches broad. This boss is again just one of those inches aside from the center of the block on which it is and the distance from the center to the eastern end of that block in its grooves is just one cubit of 25 of those inches. It symbolizes, indeed, *rule*, *measure* and *weight*. This whole ante-chamber fairly speaks with symbols of earth-commensuration and density. Passing from this ante-chamber you bow beneath the five pilastres made by grooves in the south wall, though a still lower doorway, being only $3\frac{1}{2}$ feet in height and 3 feet $5\frac{2}{3}$ inches in breadth. Then follows a horizontal passage, the height and breadth of this entrance or doorway and 100.2 inches long which takes you into the King's chamber. It will be observed that the granite work commences in the ante-chamber, excepting the 36 roof-stones which span the Grand Gallery. All else till the ante-room is reached is limestone or marble, if we may except the so-called portcullis at

the entrance below of the upward passageway. But here in the Ante-chamber commences the granite mingled with limestone. From the ante-room all is granite, the passage to the King's chamber included. It will be observed that the passages from the Grand Gallery into the King's chamber (which is the lowest, narrowest and most contracted of all the passages in the building) embrace 53 and 100.2 inches. I think it is necessary to repeat here, that the regular entrance passage to the pyramid, which runs from north to south, is a downward, gentle slope at an angle of $26^{\circ} 18' 10''$ to the horizontal stone layers. After this has traversed 988 pyramidal inches, which is supposed to represent the time in years, during which (taking the inch to represent the year) the Abrahamic Shemites remained in Egypt there strikes up from it the first ascending passage, which last after passing over 1542 pyramid inches, representing the time in years from the exodus to the birth of Christ, is continued on in the Grand or Christian Gallery. But here strikes off from it in a horizontal direction, parallel to the pyramid's layers of stone, the passage into the Queen's or Jewish chamber: while the passage to the King's chamber is simply a continuation of the same passage — by which I mean the same angle of upward slope of the 1542 inches up which we have just traversed before branching off into the Queen's chamber. 1882 inches more of the upward way takes us through the Grand Gallery and then 153 inches more lands us in the King's chamber, which is our culmination. But returning to the entrance of the Grand Gallery there does, as I have said, there strike off the horizontal passage to the Queen's chamber. Now, this passage which strikes off under the Grand Gallery, has a length of 1517.9 inches, and there is of this distance a lower floor level or indenture of about one-seventh of the whole of this passage at its farther end. The length of this indenture is 215.9 inches which is found to be a mean between the length and breadth of the floor of the chamber into which it enters on the same level. This chamber itself is a fair white stone apartment, exquisitely built originally, except as to its floor, which, for some reason or other, is rough and composed of mere rudely worked building blocks; but with this special feature distinguishing it from the other Great Pyramid chambers, namely, that, by reason of its having for ceiling a double inclined slope, the whole room may be said to have seven sides, of which seven the floor is decidedly larger than either one of the others in area. The other sides are not quite equal among themselves, unless

reductions are made, founded on some features which do exist marked into the wall, but whose full signification is not yet quite definitely made out. There is, however, supposed to be an argument for the sabbatical week of Scripture taken from the sums of the squares and which are given by the chief proportions of the room to a higher though not to an absolute degree of certainty. Taking the room, then, at the point of the greatest height to leave the apartment with six sides, such as ordinary rooms have, the sums of the squares of its radius into every dimension amounts to 60 or, as has been remarked, to 6 working days of 10 each. Next, take the major gable height, that which effectively gives the room its seventh side, and the sum of the squares there and there alone is 7, as has been remarked, typical of the divinely ordained day of rest. And not only does this chamber stand on the 25th course of masonry, but its cubic contents carefully computed (after accounting for the anomalous saline incrustations on the walls) amount to 10 millions cubic pyramid inches. This is a result to be compared with the King's chamber taken as typifying a length of two sacred cubits or 50 pyramidal inches, and found to stand on the 50th course of masonry, and to be of the cubic capacity of two 10 millions of cubic pyramidal inches. It is very difficult in this Queen's chamber to arrive at anything like the strictest accuracy in the measurements, owing to the salten incrustations on the surfaces of the walls and some dilapidations also, but the following facts and relations have been brought out: 1st. The central axis of the niche in the east wall (which so-called niche is the only architectural adornment this chamber has) is not in the central vertical line of that wall, but is removed southward therefrom by just the quantity of one pyramidal or sacred cubit length.

2nd. The height of the niche, multiplied by π and this product multiplied by the pyramid number 10, equals the vertical height of the pyramid.

3rd. The height of the niche, less the height of its inner kind of long shelf, multiplied by π equals half the base side length of the pyramid.

4th. The height of the north or south wall of this Queen's chamber, multiplied by 10 and divided by 2, gives the length of the pyramid's base side in pyramid inches; or multiplied by 2 without division gives the number of days in the solar year in pyramid cubits.

5th. The length of the north or south wall is to the breadth of this chamber as this breadth is to the height of the King's chamber from floor to ceiling.

6th. The square root of 10 times the height of the north or south wall, divided by the height of the niche equals π .

In the plan of this Queen's chamber it appears to have been intended to be at some day ventilated for there have been discovered in the north and south walls opposite to each other two air tubes. These were originally left so covered over (and being in the opposite walls of the chamber correspondingly placed), as if they were meant to symbolize a deaf man who appeareth to have the organs of hearing but doth not hear. These tubes have not yet been traced to the exterior, as smoke originated within them does not reach the outside of the pyramid and they may symbolize something in human history not yet understood.

But to return to the length of the passage from its beginning near the entrance of the Grand Gallery, I may say, if we adhere to the theory on which the modern interpretation is based, then 1517.9 pyramid inches (the length of this passage, from the commencement of the Grand Gallery to the chamber), representing years would take us from the beginning of the Christian era down to the Protestant Reformation or say the beginning of Luther's work. And if this Queen's chamber symbolizes the Jewish system, then the Jews have been in a much more stable condition since that time than in the previous ages of Christianity. The unfinished state of the floor of the chamber, however, which, as the principal explorer of the Great Pyramid, Prof. Smythe has said, is more like a substratum of the flooring generally of this pyramid than a regular floor, would indicate a very imperfect religious and civil polity on the part of the corporation which it symbolizes. It indicates unevenness, roughness and want of stability, and I think, may bear some relation to the three feet high stone at the south end of the Grand Gallery. It is found that the passage ways in the Great Pyramid were made in terms of the units of the King's chamber, which chamber is confessed to be the focus of the whole scientific design. By close engineering observation it has been deduced that at stated intervals the blocks forming separately the walls, floor and ceiling of the passage were replaced by great transverse plates of stone with the whole of the passage's hollow or square bore cut clean through them. Wherefore at these places the plates formed walls, floor and ceiling, all in one piece. And the intervals of passage

length at which those remarkable stone plates occurred were breadth's of the King's chamber. Another discovery soon followed upon this, namely, that one of the special natural problems of the Great Pyramid, that is the number of days in the solar year, is brought out by the application of that chamber standard of measure to the passages, when taken at their peculiar angle of inclination. This angle is $26^{\circ} 18' 10''$ to the horizontal stone layers, and if you lay off on just exactly such a slope as this angle necessitates, twice the length of the King's chamber, namely 412.132 pyramid inches multiplied by 2, you will find that the vertical amount by which the floor has risen at the end of that distance (technically the sine of the angle of $26^{\circ} 18' 10''$, with the radius 412.132) will equal 365.242, or the number of days in a solar year. And further, as to the passages: from the top of the entrance passage down to the beginning of the first ascending one, 988 inches, there is only one line of passage: but from that point there are two lines, one ascending, the other descending. The total length of the ascending passage is $1542 + 1881 = 3423$ inches; and the length of the descending passage, starting from the same point of bifurcation is believed also to be 3423 inches, but the measurement of this last has not been made with such a degree of accuracy as might be desired owing to the roughness of what is called the bottomless pit in which it terminates in the natural rock beneath the pyramid. Taking, however, the 3423 known and dividing it by π we have 1089.6, which is the length in inches as near as yet ascertained, from the bifurcation along the floor of the single entrance passage upwards and past its present termination (at 988 inches), outwards to the ancient finished face of the pyramid.

In closing I think it expedient to say a word or two further as to who the builders of this pyramid probably were. As may have been implied from what I have said before these were in my opinion Sethians (as according to Josephus), and who are thought by interpreters to have been those good men called in the book of Genesis "Sons of God." They were doubtless of the class which in comparatively late times the Greeks designated Scythians, the root Seth or Sith and Scuit or Scyth root of Scot, being originally the same. Caphtor was the name of the district in which the pyramid was built and this was in early times inhabited by the people called Philistines. I do not say whether or not it was inhabited by these people at the time the pyramid was built. Herodotus, however, mentions the name of the shepherd Philitis as

connected with its building, which may be thought, significant of the presence of the Philistines at its erection. God, encouraging Moses in view of the enemies before him, says:

“The Caphtorim which came up out of Caphtor destroyed them (*i.e.* the Avims) and dwelt in their stead.” And, again, in Amos 9, 7, he says: “Have I not bought up Israel out of the land Egypt and the Philistines from Caphtor.” All authorities agree that the pyramid was built by the king whom the Greeks called Cheops. Now any one can see the same root in Cheops and in Caphtor, which last is literally Caph-tir, the land of the chief; but in the word Egypt, the Greek form of Copteach, some of the letters are simply transposed, so that Aegypt is but a Greek form of Copteach, which would seem as well in English, Coptea, the land of the Copts, as in the transformation Aegypt. Would Cheops, then, the builder of the pyramid, a king of the fourth Egyptian dynasty, have been of that branch of the Sethian race called Philistines, a people also who gave their name to a country which we know as Palestine, meaning the country of the Palai or shepherds. The royal builder is also called Shufu and a variety of other forms of name, Greek forms. It has been said that the builders of the great pyramid were not Aegyptians.

Prof. Smyth who takes this ground in common with others, appears, perhaps unconsciously, to contradict himself in his calling the Egyptians Cainites and inquiring how they could have possessed the sacred knowledge and the sacred measures of the Sethians. He does, however, contradict himself, if as might be inferred from his writings, he believed in a universal deluge, for in this we learn that only Sethians, the descendants of Noah, a Sethian, survived. Now, it is the height of folly to think that a foreign people would have gone into Egypt and remained there to put up the pyramid in the face of the established powers and after they had it finished to have withdrawn, one and all, to their own country again. The Egyptian history, which should be accepted in preference to all other histories or opinions in this matter, represents it as a product of home skill and labor. It is very likely that the principle architects, designers and builders of the pyramid were Egyptian Sethians; that their cultured royal and sacerdotal classes produced the architects of the pyramid in the erection of which they used their sacred knowledge and measures. The people under the direction of the architects executed the great work. By some Greek authors this pyramid has been called Xut, which would

appear to be Chut or Scut, the x being equal to ch and sometimes sk. The original Scots of the British isles were a branch of the Sethian peoples and were called Gaels, after the name of a primitive leader of theirs, the name Scots, which is Scyths, being their generic appellation. The Israelites were of the Sethian stock. The characteristic Scythians were early nomads or shepherds of the Central Asiatic Table lands. They afterwards, or long before the Christian era, dominated not only in Egypt but in all northern Africa and in northern and western Europe.

Starting from the Persian Gulf, the Nile, and the Red and Mediterranean seas these Scythic people brought letters and arts, and commerce to the world under the name of Phoenicians. In the Israelitish family they have given to the world the Bible and Christianity. The branches of them which within the Christian era have been most heard from are the Goths, Scots, Sakai or Saxons. In modern times it is often very difficult to distinguish between branches of the Scythic stock. That Ireland was, in a sense, an original home of the Scots of Scotland seems as paradoxical as that the countries of Palestine and Egypt may have once been an original home of the Scots of Ireland. A Jew out of Palestine is in our idea, perhaps in his own, a wanderer from home, and so it appears somewhat in regard to a Scot or Scyth out of the prairie lands of Central Asia. Both of these families of the Sethic or Scythic race, including in time past the Phoenicians, seem like salt which the Almighty has sprinkled over the nations. The Sethites generally have always a *mission* amongst the human race and they rarely consider themselves at home but are always tracing back mentally or otherwise to some homestead or starting point whence they began their historic migrations.

King Cheops or Shufu, the builder of the Great Pyramid, is reputed in the tradition taken down by the Egyptian priests to have been a wicked man, and averse to the gods. They say he closed all the temples and forbade the Egyptians to offer sacrifices, compelling them instead to labor one and all in his service in building the pyramid, and doing other public works. Others say that in his old age he became pious and wrote some sacred books; and in all this reputation his brother Chephren is involved. But whosoever he was or whatsoever he was who built the Great Pyramid, it is very certain that he was an instrument in the hands of God in the accomplishment of His all-wise and irresistible purposes, in the setting forth monumentally in this most marvelous manner of things

to be revealed in due time. The Great Pyramid is a wonderful volume in stone, a book which contained the most important truths, doubtless divine mysteries; but this lithic volume remained sealed till the time had fully come for its apocalypse to be made. It is not improbable that many other interesting things may yet be discovered in the rocky pages of this great book; but, doubtless, the most important revelations it was intended to make to mankind have already been laid open; so that the principal thing now for us with respect to it is to get at the intended meaning of the symbols (especially in so far as these relate to human history) and to give them their proper interpretations in all their bearings and relations. So far it appears very plain from the generally reasonable interpretation which has hitherto been given that the Pyramid and the Bible, properly interpreted confirm and illustrate each other. If we proceed in the proper way intelligently and humbly we shall doubtless get at the proper meaning and interpretation of both; and if we approach the Pyramid subject unprejudiced and only desirous of finding the truth concerning it, we will, doubtless, find *that it as a whole (I mean taken as to its internal and external indications together) points distinctively to the cyclical repetition of history human and cosmical.*

PROOFS FROM NATURE OF THE EXISTENCE AND GOVERNMENT OF
GOD IN THE WORLD.

Whether the dogmatics and polemics of sectarianism or the ostentation and pedantry of so-called logic and rhetoric has hitherto most availed to obscure the subject of God in Nature might be difficult to say: But to me it has appeared plain that much of the cause of this very interesting subject having been kept in so much obscurity must have arisen from the selfishness and vain endeavor on the part of writers and system makers for the glorification or aggrandizement of themselves.

It is true that a writer of novels or romances is an author, according to the literal or root meaning of that term; for what he writes into book or pamphlet form, or for publication in the newspapers has to be the invention of his own genius, but it has not the foundation or elaboration in fact which history or true theology is expected to have, and is, at the most, only a vain and baseless fabrication.

Until comparatively recent times Orthodoxy did not deign to go outside of the Bible for proof of the existence of God. Within the covers of that volume of volumes, confirmed by law and consecrated by time, all authority and necessary proof was contained. In his work or rather Treatise on Natural Theology Dr. Paley went outside of the Bible for proof; but he, doubtless, would have accomplished a better result had he been less artificial in his treatment and paid less attention to the style of logic peculiar to Locke. It must, however, be confessed that Paley's treatise was a very good one for his day, produced at a time when society was beginning to awake from a long and contented rest on a sacerdotal pillow, upholstered with creeds selected with precision from nowhere outside of the book of books, and labeled on both ends with all the fulminating authority of mother church.

In his "Analogy," wherein from what has place in the present state he illustrated what will probably have place in the future, Bishop Butler produced an ingenious and useful little book. But we now think he might have been much more free in his use of illustrations derived from nature, as we understand this to be.

Nature, as the word indicates in its root meaning, is a certain

outstanding proof of the existence of the creative power and government of God in the world. What is usually termed nature means literally that which is born or brought forth, and how can anything be supposed to be brought forth unless by other than itself? Or did any one ever conceive anything as having brought forth or made itself? Or what other than almighty skill and power, can any one suppose to have given existence to what we understand as nature in its varied phenomena? In his peculiar philosophic language Mr. Herbert Spencer will tell us that nature, by which he means all the cosmical phenomena, is the general exponent to us of the existence of the "unknown." Taking his unknown as our God, his definition is, on the whole, not a bad one. Cosmical phenomena, too, are what we conceive or are cognizant of by our five senses, our senses of sight, of feel, of smell, of taste, of ear. These cosmical phenomena we designate as things, while some advanced writers now designate them as ideas, considering thing and idea as, in their line of reasoning, having the same signification. Thing and thought are variations of the same root word, for thought must anciently have meant mind, as Thoth, in the ancient Egyptian, meant the moon or the moon-God, the God of knowledge, and this word men, the same in moon, is the root of our word mind, as Thoth is the root of or the same with our word thought. One form of the name Menes among the ancient Egyptians was Thothmes, which read in another way, is Manetho. This suggests that the roots men and Thoth were sometimes compounded into one word or name, which is understood as having the same meaning as either one of its components taken singly. The root men in Menes or in our word moon, when read backward is Nem in the name Nimrod, Neb, in Nebuchadnezzar (the m and b interchanging with each other) or Num in number. After the fingers or ten digits the ancients employed the sun and moon and then the stars as instruments of numeration. Many different forms of names and words which meant the same and were exchangeable with each other, at least in written language, among the ancients, arose from their spelling the same hieroglyph backward or forward, accordingly as the hieroglyph had been made to indicate. This, doubtless, it was differently in peculiarities of style of persons in writing hieroglyphs in different successive ages, Pharaonic and Ptolemaic. This is like, as we in the modern languages begin to read from the opposite side of the line than that at which the Hebrews begin, although there is no reasonable doubt that most or

all of those languages were derived as the Hebrew from the ancient hieroglyphs.

You have seen, however, that the word thought meant originally the same as the word mind. And thing being the same word with, if not a diminutive of thought (whereof the prototype was the ancient Phœnician word Taut Egyptian Thoth), means in effect the same, a thought, an idea; that which to the mind hath limitations in time and space, whether or not distinguished by other qualities. Thing is think; to think is to thing or to thought. In thought you conceive both of space, which is no object, unless as it is defined by objective limitations, and also objects or thoughts limited either in space or time. Space infinite we cannot conceive any more than we can conceive the infinite God.

By night as well as by day, when we direct our eyes toward the firmament, we think we are looking upwards. At the same time our antipodes think they are looking upwards, when gazing on the firmament in the opposite direction. But the circumstances of the case require the conclusion that either they or we, when viewing the sky at the same time, are looking downwards. We all, however, *think* we are looking upwards, and the only reason we can fairly offer for our having such an impression is that the Creator has so constituted our minds as that we do thus *think*.

According to the derivation of the word, an object is that which is cast or placed in or before the mind. Do we not speak of casting, that is, of moulding objects into definite forms by our processes in foundries? Whether or not, therefore, it be distinguished by other qualities, an object is that which hath form in or before the mind. It would, I perceive, also mean that which is cut off from or limited in space. This is plain from the evident position that the preposition ob is originally identical with ab, meaning "from," "out of," as indicating derivation. How the preposition ab came to have the meaning "against" may not at first sight appear, but it is evidently a secondary meaning.

I simplify these examples in order to indicate thereby how necessary it is in the treatment of such subjects, as this we are now considering, to trace out the root meanings of the words, we have to use and observe how the view we are disposed to take of the subject in our progress will consist with those root meanings. If our view, at any stage of the discussion, consist not with the root meanings of the words employed, then our view in that place is not unlikely to be wrong.

Whether or not you choose to call the thought or conception the representative of the thing or the thing itself, yet the name or word whereby the thing is known is the representative or symbol of the thought or thing. This name, as I say, is a word, and, although we are taught by the best of authorities that words are spirit, yet you might, perhaps, see proper to call words, whether written in alphabetic characters or simply spoken, representative, symbolical or significative of spirit. Without Him, that is, the word, was not anything made that was made. And God brought all the creatures to Adam, who gave to them names and whatever word Adam applied to each creature, as an appellation, that was the name thereof. Are we not to understand, therefore, that God, the creator, brought those creations into or before the mind of man and that the latter gave them names, created, designated, defined them by the word or name, which he applied to them specifically and individually and by which he afterwards knew them? How long it was from the creation of heaven and earth "in the beginning" to the creation of the living creatures, in the higher kingdoms of nature; and how long from the creation of those creatures to the naming of them by man, who can tell?

The first thing an intelligent being becomes conscious of is that he himself exists. As a proof of his existence De Carte gave that he thought. "I think, therefore, I am." The next thing the intelligent being becomes conscious of is the existence of other things besides himself by the impressions those things make on his senses. He thus becomes conscious of the existence of the external world or, more correctly, of all the objects external to his own bodily limitations and which aggregatively are called the world. The word object, as indicated before, made up of ob, originally ab, meaning "from," "out of," and ject, for past-participle of jacere "to cast" or "throw," means that which is cast or thrown before or in the mind, or that which is "cut off from" space or hath limitations in space or time or both. In regard to space infinite we cannot conceive of either up or down, and so truly in regard to the infinite God, who, as a French metaphysician has elegantly expressed it, is less than the least and greater than the greatest. But all creation has been effected by the omnipotent God—(a German metaphysician remarking, whether correctly or not I do not say, that creation attained to consciousness only in man) and all things have words for names. One's experience teaches him that nothing happens in the region of his own originating without a cause.

The first sentence in the Bible says: "In the beginning God created the heavens and the earth." To know when that "beginning" was is not in the least necessary for us, we being perfectly satisfied that the expression has a literal meaning. The untutored savage in roaming over the prairie casually finds a pocket compass, and, on considering it, concludes it must have had a maker, he not being able to conceive it as originating itself. So he, as all others, naturally must conclude in regard to the world around him. Even the little boy or girl, when asked if the table or chair made itself, will promptly answer that it did not and will probably give the name of the maker of it as papa or some one else. Although there be so many different pieces of machinery in the composition of the watch or mill, yet the watch or mill, when in complete working order, is a unit, its parts being predesignedly adapted to each other with the greatest precision for the production of a certain result analogously to the parts of the human or animal body. And this watch or mill is all the product of one mind, which has conceived it as a unit in all its varied mechanism, and executed it for the attainment of a certain foreseen and intended result. So while the human mind necessarily conceives this cosmos as made up of an infinity of different parts adapted to each other with what might be called miraculous precision for the production of certain phenomena, it by this very fact also necessarily concludes it to have been the product of one Omniscent, omnipotent and omnipresent will; and that it is one whole or a unit, though made up of many parts, analogously to the animal body, the mill or the watch. The universe, therefore, is naturally and reasonably conceived by the human mind as the product of one maker, the effect of one cause, which has brought it into existence and effects all the changes in the phenomena. But in this cosmos (necessarily conceived as one whole and the effect of one cause) is there not justly conceived a duality, all things in it being arranged reciprocally? The day and night and the seasons are all set over against each other. The animate creation as well as the soil itself has its season of rest and of activity. The earth and moon are reciprocally illuminators to each other, as are all the planets and their moons in this solar system. If you were situated on the center of the moon, as that luminary appears at its full, you would see the earth in the sky right over your head thirteen times the size of the full moon to us. If your position of observation were removed towards the apparent edge of the moon then you would see the earth in the position correspondingly removed towards

the celestial horizon. Not only, therefore, are the objects themselves clearly and literally reciprocals, but their changing appearances from each other are reciprocals. Similarly conditioned do we find all the planets and their moons, which are reciprocally illuminators to each other, a moderate account of which, even of those bodies in the solar system, would require volumes. They are measures to each other in regard to day and night, seasons and cycles. They furnish to their animate species respectively and reciprocally seasons of activity and of rest. In the animal kingdom the male and female are reciprocals to each other and so in the vegetables wherein the pollen is necessary to the perpetuation of the species. Reciprocity, too, is represented in bodies in general, even the earth considered as a globe, and, as we may believe, in all earths or globes, by the phenomena of their positive and negative electric conditions. Is it this reciprocal, dual condition of existence which gives us the globular forms in the celestial bodies and the tendency to the circular trend in their orbits of motion? The spiritualists, I have heard, by joining each other's hands together form a circle and thus produce certain effects, such as the tipping of tables, knocking, etc. Could the monk of the middle ages, sitting in his cell, so curve his body as to take his great toes in his fingers and thus succeed in making an imperfect circle of himself in which condition to contemplate his existence and imagine he saw the Shekinah which had appeared about the Savior on Mount Tabor? In his circular state, however, whatever that may have really been, he is said to have experienced great happiness and to have been much favored with celestial glimpses of terrestrial things to come. It would appear, however, all things considered, that the circular form may have some virtue in it as well as the horse-shoe.

But it is seen that an observation of the cosmical phenomena as these pertain to the heavens, evidently show design as if in relation of means to ends in the constitution of those phenomena. The reciprocity referred to indicates this as well as the ineffable nicety of the order with which the celestial phenomena occur. By the law known as "the attraction of gravitation" the celestial globes of the solar system move in their orbits with the exactest precision, whether they be in *perigee* or in *apogee*, in *perihelion* or in *aphelion* their *radii vectores* passing over equal spaces in equal times. The more than clock-work precision, therefore, with which they move in their interrelations, enables us to calculate to the one-hundredth

part of a second, or even to a more exact point of time if it could be arrived at, the time at which, for example, the earth, the sun, or the moon begins to enter upon or to emerge from an eclipse, at any particular place on the earth's surface at which such eclipse will be visible. It is by observation of the eclipses of Jupiter's moons, of which there occur about 400 in one Jovian year (about twelve terrestrial years) that the Nautical Almanac is made out, which guides the mariners over the oceans and round the world. This law of the attraction of gravitation, so called, thus effects such uniformity of cosmical order as that the cosmos may be fitly designated order itself. And so in the terrestrial phenomena themselves the tendency of heat, for example, when present in more than normal quantity, is to expand all bodies, while the tendency of the absence of heat (a condition which is denominated cold) is to contract them. This tendency may be called the general law, in this case; but we find a departure from this law in the case of water, which when in a congealed or frozen state takes up more room than in its normal aqueous state. The water crystallizes into regular cubes, which expand equally in all directions, to a certain extent at least, in proportion to the absence of heat. The water congealed in the solid ice, taking up more room than in its normal state, is lighter and floats on top of the water proper. For, otherwise, if in its congelation it contracted in bulk in accordance with the operations of the law of the absence of heat in all other terrestrial bodies, it would become smaller and heavier than its own bulk of water in its normal state and would sink to the bottom instead of remaining on the top. Thus in cold countries the deep rivers would freeze to the bottom and the waters flowing out from their sources would flow over and cover the countries with a mass or heavy coat of solid ice. In this phenomenon of creation does not design with intention of means to ends clearly appear? And does not the departure from the general law in this case appear somewhat miraculous.

The story that ice of a coldness sufficiently intense will take fire, I, for my part, have never seen verified, by means of an experiment, while not here intending to cast any doubt on its possible truth. We do, however, know by experience that only elements (really compounds), which have an affinity for each other will combine, by which we have the phenomena called the world; while those having no such affinity repel each other, by which we perceive the means of the destruction (at least to some extent betimes) of the

existing terrestrial constitution. And here I would give to be remembered a matter which I was fully satisfied of and set forth in one of my books long before Mr. Lockyer demonstrated it theoretically, namely, that all the terrestrial elements, so-called (62 or more in number, I believe, as stated in the *Treatises on Chemistry*), arise from one original, call that one an element or principle or any other fit name. But what are commonly denominated elements are very often compounds arising from different elements.

Not only in all nature, as generally conceived, is the reign and operation of law clearly apprehensible by the mind, but especially is this so in the crystallization of water in its various states. Here it stands out definitely to the observation of all. Ice is, as I have said, crystallized water, while snow is crystallized water from vapor condensing in the air. Snow is all composed of crystals, wherein although a great diversity of figure is apparent yet all the angles are equal, being those of an equilateral triangle, namely, sixty degrees. In crystallography the angles never vary — they being in this the constants, and always measuring, to the greatest nicety, exactly the same; but the faces of the same form of crystal are always equally inclined. Examine a flake of snow through a glass of fair magnifying power, and you will find the whole of it composed of shining specula diverging like rays from a center. Many of the snow-crystals are of a regular figure, — for the most part stars of six rays, — and are as transparent ice as any we see on a pond or river. The almost endless variety presented by their forms, — which are generally very regular and beautiful, and reflect with exceeding splendor the rays of the sun, is the reason why snow appears white, the light being reflected from every angle and face of the infinite number of crystals. As to their natural size the snow crystals vary from the one-third to the one-thirty-fourth of an inch in diameter. In crystallization generally is exhibited undeniably the reign of law in nature and if one characteristic of beauty consist in the symmetry and proportion of parts of objects, then snow-crystals must be allowed to possess remarkable beauty.

In the contemplation of the nature and laws of light, does not design with intention of means to ends conspicuously appear? Light itself is, we know, producible in various ways; radiates from a luminous object, when in the same medium, in straight lines in all directions, and all objects are rendered visible by its reflection from their surfaces. When the rays from a luminous object strike

upon a polished surface, rather more than half of it is thrown back or reflected in a direction similar to that of its approach, that is, if it fall perpendicularly upon a surface, it will be perpendicularly reflected, but if it fall obliquely, it will be reflected with the same obliquity. Hence, the following fundamental law has been deduced both from experiment and mathematical demonstration, namely, that the angle of reflection is, in all cases, equal to the angle of incidence.

But while light, in passing through the same medium, moves in straight lines, yet if it pass from one medium to another, as from air into water, it always deviates from its original course and takes a new one. This change of direction or bending of the rays of light is what is termed refraction (from the Latin *frangere* to break or bend) and the angle of refraction depends upon this obliquity of the rays falling upon the refracting surface being always such that the sine of the angle of incidence is to that of the angle of refraction in a given proportion. Even the different strata of the atmosphere being of somewhat different densities it is seen there is no limit to the reflections and refractions of light, and the atmosphere, during the day is one great illuminated ocean from the fact that the solar rays are reflected and refracted infinitely in the system. If a ray of light, for example, be admitted into a dark room through a hole in the window shutter the ray will pass straight through to the opposite wall and by its reflection from the wall throw a certain amount of light around the whole room. If the window be not situated directly opposite to the sun the ray of light which enters must itself be of light reflected from the atmosphere or from some outside objects. From all this is clearly seen the design in creation for the purpose of the diffusion of light and of rendering visible the cosmical objects. But from light it is said arises colors; for I believe it has been determined satisfactorily by experience and experimentation that where no light is there colors are not unless as light itself in principle and that *what we name color is only the various affection of the optic nerve by a greater or less quantity of light radiating from a focal point in an imperfect reflector*. Would it not, however, be more definitely true to say that colors arise from the creative principal, that same principle, which has originated all the species, so-called in all the animal, vegetable and mineral kingdoms in this terrestrial world and all the specific ideas we have relating to all worlds and systems? From whence then has arisen all the elements, so-called, and objects and

orders and laws of creation? Why, from that one principal, as I have mentioned before, which is at once their Creator and support, the ultimate foundation upon which they all rest.

But, now, considering for a moment the spatial expense and a certain annihilator thereof, so called, which has come into operation in our own wonderful age, if we may be allowed to use the illustration, we may say that the electric telegraph points to the continuity of mind, spirit or thought, to the continuity of the principal of life and intelligence, that it is in a sense, exponential of what might fairly be termed an omnipresent consciousness. It helps the illustration of the argument, such as it is, of the omnipresence of mind or of thought contained in Victor Cousin's Analysis of Locke's well-known theory of ideas. In this theory Locke maintained that man knew the world, external to himself, only by impressions made upon his mind by external objects through the media or avenues of the five senses. According to this theory the mind of man is shut up in his cranium, by the bony walls whereof it is limited and hemmed in, somewhat as a man in a dark closet; and the windows, avenues or messengers by which it knows or holds converse with the external world are the five senses. Cousin, on the contrary, maintained that, far from being limited to the space within the cranium's bony walls the mind is most intimately present to the objects it conceives. This position being reasonably admitted, consequent upon or independently of the argument adduced by him, then as it is certain there is no limit to the mind's power of conception, so it must be admitted that the mind is, in a sense, an omnipresent consciousness; that all objects are in the mind, not external to it, and that the variations of them all are modifications of mind or spirit, or thought or word, call it by either of these terms, or by one of them now, by another again and so on. To assert that there exists not a real creation is nonsense, that is, it is contrary to what we know by our senses. But is that creation internal or external to us? It is both; internal as it relates to our mind; external as it relates to our bodily limitations. Hence we may, doubtless, have one proper apprehension of the meaning of the founder of Christianity, when in speaking of his disciples and himself in relation to each other, he seems to speak of them and him as being "in" each other: "I in you and you in me."

The cosmical phenomena, as regards seasons and cycles, come about in perfect order in time and space. Therefore in the creation, arrangement and adjustment of the cosmical objects to each other

there appears to have been no mistake made. Paley and others illustrate design in the creation by means of the machinery of a watch or clock; but the cosmical objects are adjusted and adapted to each other with a far minuter precision than that of clock-work. All the phenomena, as I have said, occur in their proper order in time and space. The appearance of the objects gives birth to space; the appearance of the phenomena in the order of day and night and seasons and cycles gives birth to time. It is only about objects and phenomena in their relations to each other and in their relations to ourselves that we can reason. It is only in his works and in the dispositions and happenings of the cosmical phenomena that we can apprehend the supreme creator, that is, speaking outside of the revelation of himself which he has made to us in his word. In our terrestrial existence we can speak only of things or ideas in relation to each other, to other things, or to ourselves; that is, we can speak only of relations; but God as infinite is not relative or an object of sense; he is absolute and undefinable. In relation to him we speak not of space or place, all spaces, places and things, all objects being creations of his. We cognize by our sense of sight assisted by the telescope the vast suns and systems, scattered in such rich profusion through the universe, and, assisted by the microscope, the numberless species of animaculæ, so fearfully and wonderfully made, which pertain to our terraqueous globe. We progress along the line of thought in any one direction whatever without our being able to find a limit to the wondrous effects of the creator's power. In all the manifestations we see evident indications of infinite wisdom, power and goodness displayed. Let us put on our pretty powerful eye-glasses on a summer's day and contemplate the industrious operations of the inhabitants of the ant-hill. What order do we observe in their movements; what an industrious and busy appearance they present! Let us look through our telescopes at the movements and the occultations of the moons of Jupiter, Uranus and Neptune with the much varied phenomena of the rings and moons of Saturn. Let us, on the one side, look down into the kingdoms or cosmoi of earth and then look up to the systems of the hosts of heaven; closely observing we shall find that order prevails in all those systems; and that while God's wisdom and power are everywhere displayed his mercy and goodness are evident in all his works.

Let us follow closely the argument on the comparative sagacity

of the land and sea fauna as found in Plutarch's *Morals*. Let us accompany Pliny, Buffon, Linnaeus and a host of other intelligent and industrious workers in the fields of Natural History, Botany and Zoology; and others many in their works on Geology, Mineralogy, Physics and Astronomy and we shall discover great funds of wisdom as we contemplate the systematic order which characterizes one and all of those systems of creation in the earth and the heavens! Then let us contemplate the arrangements which have place in regard to the earth itself; of the precessional cycle, for example, whereby all parts of the earth's surface, capable of producing, alternate as to the seasons in the progress of time. How, for example, this precessional movement necessitates that our northern and southern polar regions must needs, in their times, throw off their blanket of snow and ice and go to work to producing, while the temperate zones become polar so far as taking on their coat of snow and going to rest for their season is concerned. Hence you may partially perceive the cause of those changes, climatic and otherwise, which formerly were not so easily accounted for, such, for example, as what are called glacial epochs. Everything in its time, everything in its place, reason in all, pertains to the pre-arranged cosmical order.

Nor, do those cosmical changes, such as those called climatic, ordinarily take place with great suddenness, but rather gradually. From the conception to the parturition in animals more or less time is taken up. From the planting or sowing of the seed of vegetables to the ripening of the grain in the ear the changes are analogous to those in the animal creation. You sow the seed in the earth; it passes through a series of changes until it results in a multiplication of itself again on top. As the saying is, "it comes out on top" although you had buried it beneath the sod and it appears to have died there. This is so as to all vegetable seeds and an analogous process has place as to all animal seeds. Is it not, therefore, a proof, in some sort of the resurrection of the body of the human dead? It is not said by Paul, who is the principal and fullest authority on the subject of the resurrection that it is the same body that dies and is buried, which will be revived at the resurrection. For in reference to this he says: "It is sown (or buried) a natural body; it is raised a spiritual body." It will, therefore, so far as the human body is concerned, be the spiritual body which will be resurrected. People will not come forth from their graves filled with the pains and aches with which they entered them, nor covered

over with blotches and sores nor marked with the bodily deformities, which may have characterized them during life. As the pure metal comes forth from the refining-pot without any crude or drossy ingredient having been left mixed therewith so does it reasonably appear the children of the resurrection shall come forth unto life everlasting. They would not want some such things attached to their new and glorified spiritual bodies as formerly may have characterized their frail natural bodies, nor will they have them. We are told in the book of Revelation that they shall not hunger any more nor thirst any more nor shall they have need of the light of the sun or moon or of the other heavenly bodies, for that God himself will supply all their wants in their new spiritual state and the Lamb shall be their light. All this, of course, implies not only the non-annihilation but the eternal existence in some way, of the individual. Nor do the cosmical changes, I say, such as those called climatic, ordinarily take place with great suddenness, but gradually, somewhat after the manner of the changes enumerated. The climatic changes brought about by the precession of the equinoxes occur with such notable slowness — the movement being at the rate of only $50''\ 2'''$ of a minute of a degree of the zodiacal circle in our year — as to leave the species, vegetable and animal, abundant opportunity to extend themselves into more congenial latitudes and thereby preserve their existence independently of those which are overtaken and overwhelmed in the catastrophes. How many proofs we have of such preservations and such catastrophes recorded in geology in connection, for example, with the last glacial epoch.

The existence of the precesssional, cyclical movement shows that what we term the points of the compass are not absolutely fixed, but are always changing in accommodation to that movement, and the climatic and superficial conditions which the earth in our age presents bear evidence to the remarkable slowness of that movement, and that in the progress of the 25,827 years of the cycle very remarkable climatic extremes must needs present themselves during long periods on all parts of the earth's surface. But those extreme changes must needs, as I have said, come about with such slowness geographically as to afford to those existing species sufficient time to extend themselves into the more congenial latitudes so that sufficient may always be preserved to abundantly represent the particular species, while the change of climate into extreme cold has the effect of giving the earth rest from bearing

by the cover of snow with which it clothes it over, so it has the effect of purifying the atmosphere and rendering it healthful and salubrious for the species in the coming time. On the contrary, the change of climate into extreme heat, as now in our equatorial regions, has the effect of exceedingly fructifying the earth, so that it brings forth at least two crops in the year. The extreme heat of the sun causes such evaporation of the waters from the sea-belts, rivers and lakes within the equatorial zones, as effects that the soil be abundantly moistened by the rains and bring forth vegetation and animation in great abundance.

Was it not, therefore, for a wise and beneficent purpose that the Creator instituted, with all other things, in their interrelations, the precessional cycle, by which the different regions of the earth should have, respectively, their seasons of rest and activity, and the atmospheres their seasons of purification consequent upon those of gaseous exuberance? People talk of there being no proof for miracles, but where was there ever such an astounding miracle heard of as we can contemplate in the creation, arrangement, and adaptation to each other of the cosmical phenomena themselves. Truly God is eminently good in all his creative designs and his wisdom is conspicuous in all his works. In creation and adaptation he has in view the beginning, the progress and the issue; and his purposes never fail, his aim never misses. Let us, therefore, hear no more cry for proof of miracles, while we have all this before our view and present to our judgment.

It is certain that that in the seed or germ which develops it through all its changes, until it brings it to perfection and maturity, that, for example, which in the case of man makes him a full developed organism, endowed with the finest sense and reason, a living soul, that it, I say, never dies, never is annihilated. It is said that it is the principle of life which thus develops in the case of living beings, whether animal or vegetable. Well this is true, but this principle of life is also that of reason. All things come according to their particular kinds; but is it not evidently the same principle which develops the animal, the vegetable and the mineral? Or do you rather suppose delegated creators, secondary causes? The particular species develops in its media, without which media it could not develop. Is the media, then, a delegated creator, a secondary cause? Or is each one of the medial elements, as well as the principle which they environ, a delegated creator, a secondary cause? The simplest idea of creative operation is found to consist

most with reason and with the facts of the phenomena, when the whole cosmical subject is considered. The one creative, directing mind governs all the originations and processes; you may name the elements and principles, so-called, secondary causes. Unless the seed happen into a media favorable or congenial to it, it cannot develop. Things have to have a constitution before they have a development. It is, of course, a mysterious subject, simplify it as much as we may, but theology speaks of God as that Being in whom we live and move and from whom we derive our existence. It also speaks of God as self-existent, present everywhere[at all times, that he is what he is, unchangeable and so on. But the cosmical phenomena and the marks of unity in diversity displayed in their constitution, the marks of contrivance and design with end in view, evidently suggests not only creation, but disposition and arrangement, on the part of an all-wise and omnipotent Creator. Are not all things disposed and arranged in relation to each other, not only in regard to the celestial phenomena, but to the terrestrial species? The interrelations of the celestial objects, prearranged with the view of means to ends, have always appeared with such remarkable precision, as to time and space, and with such remarkable interharmony of result by way of change, that none have failed to notice them in these respects. But how many books have been written in elucidation of the subject of design with intention of means to ends in the creation of the terrestrial species, animal, vegetable and mineral? Books which were instructive and useful in their day and are still found to be exceedingly interesting and profitable, See, for example, the vast diversity in the species without confusion or contradiction! All the ancient natural historians, along the line of Pythagoras, Plato, Plutarch, Pliny, and the rest, have supposed what they thought the observation of their unassisted sight justified them in supposing, namely, that no two individuals in any one species in the earth or oceans were exactly alike in every respect in which they might be contemplated. The invention and perfection of the microscope in modern times shows this, their supposition, to have been probably well grounded. Now, taking the matter of diversity of appearance in the individuals of the same species home to ourselves of the species man, I may say, my hearers, that if any one of you were in a distant city and saw a person on the street who, you thought, looked exactly like yourself you would be somewhat surprised and would, perhaps, approach the stranger with a degree of timidity. Having come up and

looked closely at the stranger you would find that he did not look exactly like you, that there was some difference in some way in the appearance between you. And now what is the reason of this diversity of appearance in the individuals of our species; for men say there is a reason for everything? Why, the reason is apparent, namely, that it was not the intention of the author of our human cosmos, who is, indeed, the author of the universe, to make two of us human beings exactly alike. He had no necessity whatever of making two individuals of us exactly alike in our external appearance, nor, certainly, has he any more need of confusion or disorder among the most intelligent species he has created than among those of inferior orders. If human beings are disorderly their disorder will have to arise, in some way, from themselves, not from God who is not the author thereof and who, so far as their being disorderly is concerned, has left them without excuse, having suggested to them, in so many ways, he has made provision for and approves of order.

And now a word on a matter which has long impressed me: There will hardly ever occur an actual disruption of the earth's surface in any locality without first a premonition or warning being experienced, in the way of earthquake. If people have good reason to know that such a disruption is about to occur in their locality it is their duty to remove to another, saving all of their property which they can or which is necessary for life; and it is the duty of the executive of their nation to immediately step forward and make provision for them instead of what they have had to abandon. If individuals and much property have been lost by such an occurrence it is the duty of the executive of their nation to provide for the survivors and reimburse them for what they have thereby lost. Is there not sufficient money in the treasury? Let the people at large contribute at once for the emergency freely out of their funds until the executive shall have drawn in sufficient means for the emergency by an immediate levy on the whole nation or on such prosperous province as they decide on. If such local loss occur there is always abundant means left, and governments, being instituted for the preservation and happiness of the whole people, God always requires the *de facto* executive to act as a parent to the suffering community, to preserve, comfort and reimburse them for what they have lost.

Yes, God approves of order and right, and hence we observe the greatest order amid the most remarkable diversity in all the species

in the realms of nature; for the author of nature is infinitely competent to bring about the results just as he does. He is infinite in his contrivances to bring about such diversity and in his wisdom to have such order rule therein. This order is law and this law may be called the will of the Supreme. Observe again the ant-hills in any part of the world, in Europe, Asia, Africa or America, and you'll find much the same habits in regard to order and method, to characterize the ants everywhere. Does any one ask me, in what quarter of the globe I suppose the cradle of the antite-race to have been? or, in other words, where the pair of ants were created to which all the ants now in existence, in all parts of the world, trace their lineage. There are some people so curious as to habituate themselves to ask questions of such a nature as they must know can be answered only hypothetically. This question as to the local cradle or originating place of the ants we cannot answer now more definitely than by saying that we at present have ants in all quarters of the globe, which display in general the same habits of life, habits which are so eminently distinguished by order and industry as to attract the attention of the intelligent in all ages. Even Solomon in Chapter VI., verses 6th to 9th of his Proverbs in his inculcation of habits of industry and order to the people forever, says: "Go to the ant thou sluggard; consider her ways and be wise: Which, having no guide, overseer or ruler, provideth her meat in the summer and gathereth her food in the harvest." Yes, in all ages and nations, the ants have been known as a race of orderly habits and the praise of their industry has been frequently heard.

But even a more systematic order, if anything, than we have observed as characteristic of the habits of life of the ants is said to obtain in the habits of life of the bees. These communities suffer no drones among them. If a bee choose to live the lazy life of a drone it will have to pick itself up and leave the hive. I know not whether in the organized government, which some naturalists say they have, the functions of the queen bee would correspond more to those of the sovereign of a nation than to those of the presiding officer of the common council of one of our municipalities, a functionary usually called the mayor? From all accounts, however, we gather the queen bee is a very important personage, her prerogatives being considerably great, and her powers being exercised generally with discreteness, although sometimes with severity. In some respects her functions might seem to be monarchical, or, if

you will, aristocratical, but in general it would appear more democratic. Even among those kinds of animals usually regarded as the most stupid, occasionally one shows itself possessed of remarkable sagacity. A short time ago I was told of a calf which, having been weaned and placed in a pasture four miles away broke through the fence and came back across lots that long distance, till it found its dam again.

The discussion in Plutarch's "Morals" as to the comparative sagacity of the animals of the land and sea affords some exceedingly interesting illustrations in proof of animal sagacity. In this discussion, although it might appear, on the whole, difficult to determine as to which of those classes of animals possessed the more sagacity, yet several examples, in illustration, might seem to justify a verdict in favor of the marine animals, while the discussion of the whole subject might make it in favor of those of the land. Professor Whitney, in his very able and useful treatise on language, maintains quite strongly that the principle of reason is distributed more or less throughout the whole animal creation, and that what is termed instinct and sagacity in animals is nothing less than reason in different stages of its incipency: Following out this argument he maintains that each of the different species of animals has a language of some kind, say of signs, of sounds or otherwise, peculiar to itself, and which it understands and utilizes. His position on this subject is, of course, such as might be supposed to be held by a learned professor of high standing in the faculty of Yale College, which is that man is that being that is by the Creator most highly endowed, that being into whose nostrils God at the beginning breathed the breath of life and constituted a living soul; that being in whom the principle of reason is most highly developed. Man is surely a highly endowed being and his responsibilities (beyond those of the inferior animals) are correspondingly increased, first to God who is above; then to his fellowmen, and then to the creatures which are below him in the scale of existence.

And, now, speaking in regard to arrangement and adaptation of means to ends in creation are there not many people who notice the general operations in nature taking place before them all their lives and never notice in them any mark of design or of adaptation of means to ends. They see, for example, the water taken up by a peculiar process called evaporation from the surfaces of lakes, rivers and seas, into the air, conveyed a thousand miles overland and then let down equably upon the earth's broad acres as it were

through great sieves. All this takes place in order that the earth may bring forth, that the vegetable and animal creations may be supported and perpetuated and that the aerial, elemental fluids may be equalized and equalibrated. In this manner also, as I have before intimated, when speaking of the effects of the precessional movement, there takes place an equalization of the magneto-electric polar forces, the forward action of the positive upon the receptivity of the negative effecting an equalibration. By this contrivance, it is seen, the earth is baptized by aspersion or by a process of sprinkling, which (although the river Nile baptizes its protégé by immersion and parts of the Mississippi valley are baptized by the waters descending upon them in great aqueous sheets) may still be called the general mode of the earth's baptism.

In the constitutional arrangement, in regard to the earth's system, the water appears to hold the place of father as in the human family, as well perhaps as mother, the f in father being the w in water, as well as the m in mater or mother is the eponym of the same in matter. The liquid and the solid are both alike matter, but, in the common mind, there is usually connected with the word matter the idea of solidity. It would seem that we might be justified in considering the idea of the ancestors to have been that the word matter represented the solider parts of the terraqueous globe, more especially the productive or arable soil, the fructifying mother, while the same word with its first consonant varied represented to them the fluid or liquid part of the globe, which had to be superinduced upon the solider parts in order that its surface become fruitful and productive. Now, in the ancient language, the Gaelic for example, them aspirated stands for our f or w, but this letter being left broad in the word matter, mater or mother, while it is softened in the words water and father, indicates that in the former case it stands for a more solid thing, represents, as we would say, a harder consistence. Following out the same line of thought we have wind, which is the German kind, a child, properly a son, kinder, children. Hence we have water, answering to father, matter to mother, wind or kind to son, the air, the sun, representing the liquid, solid and aerial or celestial elements of our media. In the media, in which we are, be it noticed, the aerial of the triune comprises in itself also the solar and celestial: So that the whole might be fitly designated in their order of importance, if we may so speak, the liquid, the solid (that is pertaining to the solil) and the aerial (which comprises also the solar and celestial). Of course

no preacher is necessitated to take this exact line of thought in proving or illustrating the mode or manner of existence of the Almighty and omnipresent God, but any one may use it as an illustration of how language has arisen and how names have been applied to things, as it appears, according to some quality contained or apparent in the things themselves. In regard to the way and manner of the existence of God it may be borne in mind that we are instructed in the good book that God is a spirit and invisible; that this is proved to be true by the fact, brought to our mind by science in modern times, that all power (which of course implies all intelligence) is invisible; that what we come to know of power and intelligence are the effects or marks of that power and intelligence which impress themselves upon our senses; but that God, considered as infinite and invisible cannot be comprehended by the human mind.

It might, however, appear plain that the idea of father, mother, son, may be the old patriarchal triune idea. You see the words father and mother in the words water and matter, respectively, and the word child (which here stands for son) is cind or wind, the l, n and r, being letters of the same organ and often interchanging with each other, as the c or g is the original of the f or w. Cind is the same original that has come into our words wind, son and sun; the Latin con and the Greek sun, a preposition, meaning with or together. And in all this is clearly indicated the idea of the family, which implies the idea of collection (together, with) and also that of perpetuation (son). The father contains, in principle the son or child, which attains existence by means of the mother. In the Phœnician Mythology in relation to the seven cabiri, "the eighth" was said to have contained all the seven. This is the same, in other language, with the Arkite religion in which "the eighth" stands for Noah. There were Noah and his wife and his three sons and their three wives. Through means of Noah's wife his three sons came into existence from himself; and their three wives would be simply the means of perpetuating the race of Noah. It is still, of course, the idea of the family, viz.: father, mother, son, and is symbolic of the perpetuation, continuance or ever-presence of the race of man. The Trinity of the New Testament and the creeds may have had a distant reference to this idea. In it the son is "in the father" and "is the father," which we can see corresponds somewhat with the ancient patriarchal idea, that we have now considered. But the New

Testament Trinity appeareth in the ideal more obscurely and may be meant to refer to God the Creator and governor of the world.

But, now, it is worthy of observation that although the mother be only the means through which the father is perpetuated, still without the mother there could be no continuance of him and in this way, to this end, the mother is as important a person of the original and originating duo as is the father. This is illustrated by the earth in its relation to vegetables, holding, indeed, such a relation to them as that it may be termed their mother.

The condition on which the seed perpetuates itself is that it be imbedded properly in the soil and that this earth or soil be kept properly moistened with water and surrounded and (to as great an extent as its density will permit) interpenetrated with air. You perceive, therefore, the absolute necessity not only for the co-existence, but co-operation of the three elements, called the liquid the solid and the aerial in order to the self-perpetuation of the seed in vegetables.

And so, as to animals, which are of a much higher type of existence than are vegetables, there is absolute necessity of the co-existence and co-operation of the male with the female in order to the continuance of the male in the offspring. And, moreover, there is necessity not only of the father and the mother, which we, among men, call the parents, co-existing and co-operating, but of their being placed in the ordinary terrestrial media, called, earth, water and air in order to the continuance of the race.

And, now, take an individual of any one species of existence, be it animal, vegetable, or mineral, this individual is made up of the one kind of substance peculiar to that species. The aggregate of the individual in each species is made up of additions of homogeneous littles to itself, some of which attain to a harder consistence, as in the case of horns, hoofs, bones, teeth, skin, grizzle and the like, than do other parts, such as flesh, fat, etc., in the case of animals. All that pertains to the make up of any one individual of any one species belongs to that species *per se* and is specifically different from the substantial make up of any individual of any other species. St. Paul, in his epistles, refers at good length to the specific differences in these respects.

There are said to be enough spawn in the milt of a single codfish to stock the ocean, and all the individual fish which would be derived from that one would be but repetitions of itself.

You plant, in the earth, the seed of the tree: Its root strikes

downwards, so as to give it sufficient firmness to withstand the shocks of ordinary storms and to gather nourishment for the stem in its shooting upwards. The upbuilding and organizing principle in the seed; the principle of life, seeks its nourishment from its mother earth. To this end in order to the accumulation of nourishment, do the roots extend far and wide and the rootlets multiply about the roots. As the stem extends upwards it sends forth branches, which, in their turn, send forth branchlets. These branches with their branchlets, striking out from the stem, as it extends upwards correspond to the roots with their rootlets, striking out from the stem-root, as it extends downwards. Now, mark you, each branch sent forth from the stem is a little tree of a tree and each twig sent forth from each branch is a little branch of a branch. This way of explanation is true also of the roots and rootlets, so that, as you perceive, the aggregate of the individual tree is made up of the additions of homogeneous littles to itself or rather to the original and substantial principle in the seed.

And not only this, but the stem and branches are in their aggregate made up of undeveloped leaves, which never have advanced further into the leaf shape than undeveloped buds, which become pith and in a harder consistence, woody fiber. Pith then or wood-substance is composed of undeveloped buds and buds are composed of undeveloped leaves. And may it be necessary with what you already know about this subject, but may have forgotten, that you be here reminded that the animal kingdom with which we are most conversant may be understood as classed into two divisions — the mamiferous or womb-bearing and the oviparous or egg-bearing; and that the vegetable kingdom with which we are most conversant may, in like manner, be understood as classed in two divisions, the Cryptogamous or spore-bearing and the Phaenogamous or seed-bearing? That the higher department of the animal kingdom is also classed in two divisions, the Vertebrates and Articulates, or those having an internal and an external bony skeleton respectively? That besides these two superior sub-kingdoms mentioned, there are also in the animal kingdom inferior sub-kingdoms called in order Molusca, Radiata and Protozoa, which are variously and more or less distinguished from each other? That the Phaenogamous or highest vegetable sub-kingdom is likewise divided into two remarkable classes, the exogenous, or those which increase by accretions of their wood-sub-

stance in rings of annual growth; and the endogenous or those which increase by internal depositions of their wood-substance in a somewhat spiral way? That the lowest sub-divisions of the Vegetable Kingdom consist in order of the Sea-weeds, Mosses, Lichens, Ferns and all such as have spores instead of seeds? That the sub-kingdoms of the animal and vegetable kingdoms may be said to correspond to each other, in their gradations, somewhat analogously to the colors of light, until it is difficult to distinguish the lowest of the animal from the lowest of the vegetable kinds, or the lowest of either from certain conditions of inorganic matter or mineral, perhaps somewhat analogously to all the colors of the spectra combining in the formation of white light. But that, moreover, the highest of the animal and vegetable sub-kingdoms are distinguished from each other in that the individuals of the former derive their nourishment from external nature by means of an internal cavity, the stomach, while the highest vegetables derive their nourishment direct from the soil by means of external appendages, the roots?

Now, without, in this connection, entering farther into the comparison or mentioning anything directly as to marks of design, indicative of means to ends, which you must all have noticed yourselves in the constitutions of the kingdoms of nature, I may say, that if we take a fairly developed leaf of any exogenous tree or vegetable we shall find that leaf made up of what we may term, for the purpose of explanation, an extended back-bone, from which strike out on both sides, with an order characteristic of the particular kind of leaf that it is, what may be termed ribs. These are all connected together as a web by means of the very many (as we may term them) back-bone-lets and rib-lets, sent forth from the so-called back-bone and ribs and interweaving closely with each other. This back-bone and those ribs of the leaf also correspond to the roof pole and rafters of a house; and, indeed, if we exchange the initial l in leaf for r, with which, in the ancient Egyptian, it was identical, and, in the modern languages, it is so often found interchanged, we shall have reaf or roof for leaf. Even this far of the discussion gives you to understand that the animal and vegetable kingdoms are primarily constructed on the same general plan, the branches (Latin brachium an arm) in the vegetable answering to the limbs, fore and aft, in animals; the main stem root of the tree to the tail, which (the l being anciently r also) is simply the word root, read backwards; and the foliage and flow-erage (which come out generally in a somewhat globulated form

toward the top) to something analogous to what we might well be allowed, for the purpose of illustration, to suppose the animal head would develop into, were it to develop without being subjected, as it is, to the limitation of a cranium. In reference, however, to the apparent correspondence of the tail in animals to the root in vegetables, I may say that I see no good reason to suppose that animals ever sprung from the earth after the manner of vegetables or otherwise than in the way they in general do now. Perceiving an analogy of some of their parts to parts of the trees, the ancestors doubtless gave to those parts the same names. Most that is necessary to be said in relation to this farther is that the general appearance of the different species may be indicative of their grades, as we would say, or stations in existence.

Anciently the roof was the whole of the house, there being not only no ten-story buildings at that time, but not even side walls to such a one-story building as they then had, that is a tent or a construction after the manner of a tent. Some ancient sea-faring peoples were wont to extemporize a house out of their long boat or ship, which, the trading season being over, they drew up upon the shore, much above tide-line, turned bottom side up and used as a house. Curve the two sides of a leaf slightly towards each other and you have a sort of boat; close them up in front and you have the form of the animal body. You will notice, however, the word boat is but a variation of booth, which, in the Hebrew, and, in effect, in the Gaelic, meant a kind of tent, constructed out of the boughs and foliage of trees. Any one can easily perceive how much more complicated a machine is the body of the animal than that of the plant or vegetable and of how much a higher type of creation is the animal than the vegetable kingdom. The superiority of the human structure to that of all the animals, when the erect and commanding form and all other things pertaining thereto are relatively considered will clearly appear. But, as the human structure is evidently superior to that of the animal kingdom in general and this latter to that of the vegetable, so that of the vegetable is superior to that of the mineral. While the vegetable and animal kingdoms are called organic, because their structures are made up of organs designed and adapted for the performance of certain functions in their respective economies, the mineral kingdom is called inorganic because of the simplicity (though varied into many forms) of the structure of the minerals. Each mineral *per se* is supposed to be made up of an aggregate of

homogenous parts, without any organs apparent for the performance of particular functions. Minerals, as I have said, are classed under the head of inorganic, but, in their formation, chemical affinity is generally found to play a very important part. Some crystals, for example, in their formation so act as if they might be said to display a certain kind of instinct. They are found to assume the different and distinct forms they do in obedience to the particular elements which enter into their composition. The law of symmetry, too, is one of the principles upon which creation is carried on. It is observable in many species of trees, for example, that in their ramification and foliation (I am not now speaking in regard to their stem) they have a tendency towards the globular form. Some botanists, among whom we may perhaps reckon Prof. Le Conte of the University of California, suppose the reason those trees do not arrive at a more complete globularity, as regards their ramification and foliation, must be because many of the young branches, which the stem puts forth, die in the bud process. It is observable, too, in every organic structure that about a certain plane or planes the structure is built up, as for example, there are two sides of the leaf, two halves of the human body, four sides of the pyramid in relation to its perpendicular, etc. And so crystals are arranged symmetrically about imaginary lines and according to the direction of those axial lines of symmetry crystals are arranged into six classes. Wonderful indeed are the peculiarities displayed by crystals, the relation of which would require a volume. That French savant, who, in the days of the great Revolution, called crystals the most perfect type or form of God has been accused of blasphemy. I do not think he could have meant to say that crystals presented any form of God, but, most likely, what he intended to say was that crystals are some of the most beautiful forms or types of God's creations, for those, as all other objects of our senses, are phenomena or creations. Crystals, of course, assume forms in accordance with the elements which enter into their composition; and when one of them is broken and placed in proper condition therefor it puts itself to work immediately and accomplishes its reparation. So all the varieties of rock have their particular forms more or less sharply defined, even the different clays, in the process of petrefaction, assuming forms in agreement with their kinds respectively.

And, now, is not all this evidently in accordance with a design or purpose, which has always existed in the Creator's mind, and

which, being his ever-present will, has been, from the beginning, impressed upon the creation. There can be no reasonable doubt that the same or analogous laws hold in all worlds and operate in the development of the cosmical phenomena peculiar to each as we find to hold and to operate in our terrestrial world. A reference to the astronomical lectures of Dr. Thos. Chalmers will show you that this is the reasonable judgment of some of our wisest, most scholarly and most philosophic minds. By means of the phenomena of the distant worlds as compared with those of our own, microscopic and others, Chalmers proved not only the existence of God from nature, but the most probable presence in each world of such intelligences as man, who are in their respective spheres engaged in the worship and service of God. But in our own terrestrial dwelling we can ascend to the highest point of life, as in man, who stands at the head of the highly organized animal kingdom, and descend to the lowest of life's developments, as in the lowest species of vegetables. We can then descend to the mineral kingdom and to the unorganized masses of matter, which seem to partake of no apparent form, until such time, perchance, as it may begin to form into rock. In all those regions and departments, we behold the reign and rule of law, of such law, I say, as is evidently the ever-present will of the supreme God.

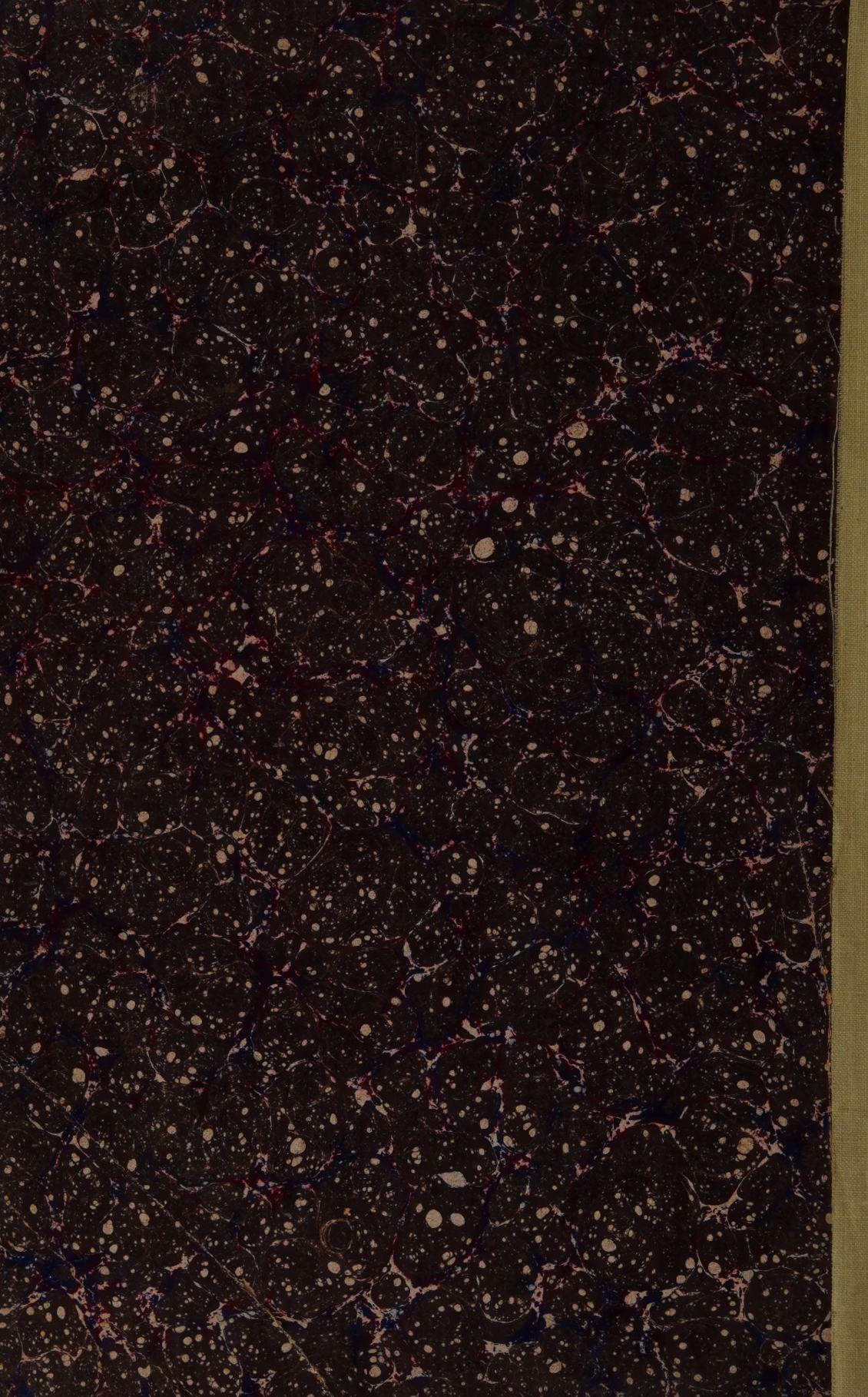
Certain cosmical phenomena, such as the descent of bodies near the earth's surface towards its center (which may perhaps be properly called the tendency of smaller bodies towards larger ones by way of attraction) having been observed to take place in most cases with remarkably definite uniformity, this tendency was called "the law of the attraction of gravitation." But this law, so-called, is the same precisely as the law of light, the law of heat, the law of electricity, the law of magnetism and the law of the motion peculiar to all these, that is, all these phenomena are governed by the same law. This general law is also called the law of the inverse ratio of the squares of the distances, which is illustrated as follows: Suppose two persons, A and B, sitting at the same distance from a bright fire reading a book; it is plain we may suppose them each to receive the same degree of light and of heat; for whatever reason may be given to show that A receives more or less light and heat than B may be given to show that B receives more or less light and heat than A; therefore, they must each receive the same quantity of light and heat. Now, suppose B remove to double the distance from the fire that he was at when alongside of A and A remain in

the same place, it would then be naturally supposed that B would receive *only half* the quantity of light and heat that he did before; or that A would now enjoy *double* the quantity of light and heat which B would receive in his new position. But such is not the case, for the degree of light and heat does not decrease at the same rate as the distance increases, but at a much greater rate, which is as follows: The light and heat received at the distances of 2, 3, 4, 5 feet, for example, is not $\frac{1}{2}$, $\frac{1}{3}$ rd, $\frac{1}{4}$ th, $\frac{1}{5}$ th, the light and heat received at the distance of one foot, but it is $\frac{1}{4}$ th, $\frac{1}{9}$ th, $\frac{1}{16}$ th, $\frac{1}{25}$ th, etc., of the light and heat received at one foot. Thus, B will receive at *double* the distance only *one-fourth* of the light and heat he received when alongside of A, instead of one-half as a person would at first thought suppose; and this is what is meant by the law of the inverse ratio of the squares of the distances. When, too, I have illustrated to you this law in the case of light and heat I have at the same time illustrated it to you in the case of electricity, of magnetism, of the attraction of gravitation and of the motion peculiar to all these phenomena. Now, all those forces or phenomena are convertible into each other, as is abundantly proven by Grove and others in works upon the conservation and correlation of the physical forces, and fully illustrated by Herbert Spencer in his philosophical works: viz., Light into heat, heat into electricity, electricity into magnetism, the attraction of gravitation or their peculiar motion; and each one back again into glorious light, which illumines the world, and gives to the flower, to the peacock's feathers, those of the Brazilian parrot, and the Palestinian dove their exquisitely beautiful colorings; and to the rainbow, and the crystal flashing in the solar rays, as well as to the whole face of nature, their most delicate tints and glorious combination of hues; or again, they are all convertible into heat which revolutionizes the world, the operations of nature and the modes of life. Now, how any one, with all this in view, and with all the marks of design of means to ends in the cosmical phenomena present to his mind, can think this general and governing cosmical law to be other than the ever present and intelligently acting will of the Supreme God, I know not; nor do I know by what process any one can arrive at the idea of blind law governing this cosmos. The general theory obtaining hitherto is that in obedience to the law of the attraction of gravitation, not only the moon tends toward the earth, as to the heavier body, which, however, it is kept at a certain distance from by the operation of another, a contrary law, causing it to move in a straight

line; but that water always moves down hill and that all bodies on or near the earth's surface, as being so much smaller than the earth tend towards its center. No reasonable doubt exists that this law; called "the attraction of gravitation," does effect to give to the worlds such orbits as they have in space; but there are many phenomena connected with our terrestrial world which appear to act contrary to this law; for example, how that the sap or liquid-juice ascends in trees; how that men and animals as well as vegetables, even to the giant trees of the forest, grow upward from the earth. Now, if those animals and vegetables were attracted to the earth's surface in proportion to their weights as compared with that of the earth, they would never ascend an inch from its surface; we should neither have men, elephants nor sequoise trees on the land, nor whales in the ocean. That the law, so-called, of "the attraction of gravitation," therefore, is not a blindly acting force or rule, but an ever-present supreme will, in obedience to which all the phenomena in existence appear, continue and disappear in time and space, is entirely certain. In obedience to your will your toe, finger or eyelid instantly moves, or any particular part of your body becomes instantly sensitive and alive. Although we must confess that in doing so we may be using the ridiculous in illustration of the transcendently sublime, still the illustration will serve to show you that God's will, which is omnipresent, omnipotent and omniscient can with infinitely greater ease effect his purposes than you can with your insignificant will effect yours, and so our illustration will be permissible and in place. Moreover, the omniscience, omnipotence and omnipresence of God's will shows conclusively that his will is law, properly so called, and that it is in obedience to it, and determined thereby that all the cosmical phenomena come about. The knowledge of this enlarges the volume of the Bible, which tells us that the heavens and the heaven of heavens contains not God by way of limiting him. Of him, therefore, we can as intelligently read in his Book of Nature as in his Book of Revelation, if not more intelligently. All the phenomena of nature in the earth and heavens are sentences, pages, chapters in this book. We need not artfully bring you to study the construction of the natural human eye in order to show you therein proof of the wisdom and contrivance of God with intention of adaptation of means to ends and the like; nor of the artificial eye, called the telescope or microscope, all of which eyes, both human and artificial, are from the same original as is clay and sand; but we can bring you to study and contemplate

at length the general phenomena of the terrestrial formations, and, among the rest, of rocks from clay, which will be a subject quite as worthy of place in the study of God in nature, or of the proof of his existence therefrom, as is that of the human eye or of any assistant thereto invented by man. It is that God whose glory the heavens declare and whose handiwork the firmament showeth, in whom we live and move and have our being. It is he who has created of one blood all men on all the face of the earth, and has been pleased to call them his offspring. It is he whom we should worship in the beauty of holiness with reverence and Godly fear!





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